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CONTENTS

Page

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PROPOSING CREDIT RISK WARNING FOR COMMERCIAL BANKS' CORPORATE LENDING IN VIETNAM

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In this paper, the author has conducted researches and investigations about risk management in Vietnamese commercial banking system. 210 observations from companies were collected by survey and SPSS software was used to perform Maddala's Binary logistics regression model (1984) to find out individual impacting factors that affect the loan repayment ability of corporate customers. Results from above process were aligned by affecting power for better evaluation, thus support banking managers in disbursement decision making, reducecredit risks.

Keywords: *warning models; credit risk; logistics model; financial factor; non-financial factor.*

1. Introduction

Credit is the major activities of the commercial banks. Therefore, credit risk is the biggest risk that these banks have to be faced, especially in the severe competition background in the field of currency trading like nowadays. There are many reasons which lead to the credit risk, and one of the most common reasons come from borrowers. Therefore, the evaluating customer information as a basis for making credit decisions is very necessary. In the world, there have been lots of researchers related to credit risk warning, each model has its own advantages and strengths. However, each model focuses on a certain aspect but is not comprehensive and most focuses on analyzingfinancial factors. Based on that fact, the paper proposes a credit risk warning model based on analysis financial and non-financial factors to estimate probability repayment and non-repayment of customers' loans are businesses, thereby helping commercial banks reduce credit risk.

2. Literature review

Credit risk management is a very important activity that every bank cares. Currently, there are many research projects related to this field in the world, in which the Merton Model (1972) is typical. This model shown loan repayment ability of a company is based on calculating the value of that company's assets at a given time. Z point model (Altman, 1968) calculates the customer' loan repayment ability based on historical data of the affecting factors. This model used multi-factor differential analysis method to quantify the customer's bankruptcy probability to surmount the disadvantages of the qualitative model, thus contributed positively credit risk managements at commercial banks. CreditMetrics model was introduced by JP Morgan in 1997 which became commonly used in modern. This model is considered to be derived from the Merton model. However there is a fundamental difference between CreditMetrics model with Merton model that the bankruptcy threshold in the

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CreditMetrics model is determined from credit ratings rather than from debts. Therefore, this model allows managers to determine both the bankruptcy credit decline probability. In addition, Meyer and Douglas W (1996) used quantitative methods to support credit risk management.

In general, each model has its own advantages and disadvantages, most of which focus on analyzing financial factors without mentioning non-financial factors. In fact the influence of non-financial factors is enormous. Stemming from that reason, the article proposes a credit risk warning model for the case of corporate customers, thereby helping commercial banks have more additional tool in helping to make credit decisions.

3. Methods

3.1. Theoretical model – Logistics model

Binary logistic regression model [Maddala (1983)] is a quantitative model in which the dependent variable is a dummy variable, only two values are 0 or 1. This model is widely used in general economic analysis and particular credit risks. More specifically, this model can help the Bank determine the ability of customers to have credit risk (dependent variable) on the basis of using factors that affect customers (independent variables).

Data structure of Logistic model:

Table 1: *Convention of dependent and independent variable*

Variables	*Sign*	*Species*
Dependent	**Y**	**Binary**
Independent	**X**	Continuous or discrete

Y is a binary variable that can only accept either value 0 or 1

Y = 0: Customers are unable to pay debts

Y = 1: Customers are ability to pay debts

Probability to Y = 0: p

Probability to Y = 1: 1-p

There are 2 types of logit regression:

Single logit regression:

$$P = \frac{1}{1+e^{-(\beta_0+\beta_1 X)}} = \frac{e^{\beta_0+\beta_1 X}}{1+e^{\beta_0+\beta_1 X}}$$

$$1\text{-}p = \frac{1}{1+e^{\beta_0+\beta_1 X}}$$

Odds of events occur:

$$Odds = \frac{p}{1-p} = \frac{1+e^{\beta_0+\beta_1 X}}{1+e^{-(\beta_0+\beta_1 X)}} = e^{\beta_0+\beta_1 X}$$

$$Ln(Odds) = Ln(\frac{p}{1-p}) = ln\left(e^{\beta_0+\beta_1 X}\right) = \beta_0 + \beta_1 X$$

Or: Logit = Ln(Odds) = $\beta_0 + \beta_1 X$

Consider the change of Odds when independent variables (explanatory variables) X increase by 1 unit (from X to X +1). We have:

Khi $X=X_1$ --> $Ln(Odds^1) = \beta_0 + \beta_1 X_1$

Khi $X=X_1$ --> $Ln(Odds^2)$ $\beta_0 + \beta_1(X_1+1)$ Ln(Odds1) + β_1

$$\rightarrow \beta_1 = Ln(Odds^2) - Ln(Odds^1) = Ln(\frac{Odd^2}{Odds^1}) = LnOR$$

$\rightarrow$ OR = e^{B1}

Meaning: Increase 1 unit of independent variable is $Odds^2$ equal to e^{B1} time compared with $Odds^1$. If $e^{B1}>1$ (or $\beta_1 > 0$), $Odds^2$ increases e^{B1} time $Odds^1$ ($Odds^2 = e^{B1}$ *$Odds^1$) and opposite, if $e^{B1}<1$ (or $\beta_1 < 0$) is $Odds^2$ decreases e^{B1} time $Odds^1$.

As in linear regression, we estimate the parameters β_0 and β_1 from the sample, then use appropriate statistical tests to consider their statistical significance.

The hypothesis is:

H_0: $\beta_0 = 0 \rightarrow$ independent variable does not affect the probability of event occurrence;

H_1: $\beta_1 \neq 0 \rightarrow$ independent variables affect the probability of an event occurring.

In case of regression logit regression then:

Logit = Ln(Odds) = $\beta_0 + \beta_1 X_1 + ... + \beta_k X_k$

3.2. Research model to assess credit risk for corporate customers

Dependent variable

Y: Repayment

Y = 1: If the customer is able to repay

Y = 0: If the customer is unable to repay

Independent variables

The general logistic regression equation has the form:

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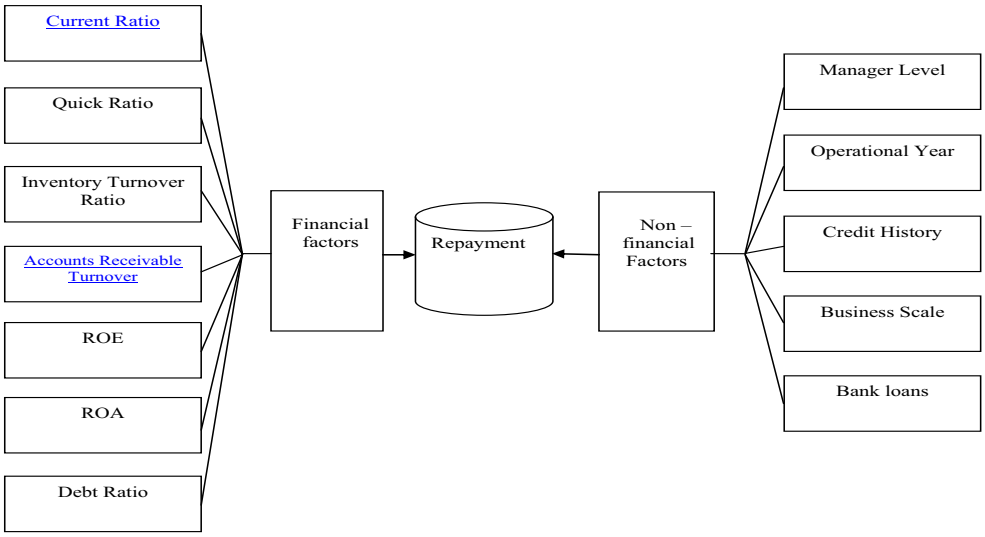

Figure 1: *Model for the effect of independent variables on debt repayment capacity*

Table 2: *Information of independent variables*

Ordinal Numbers	*Variables*	*Scale*	*Hypothesis*	*Symbol*
1	Current Ratio	$\frac{\text{Current assets}}{\text{Short – term liabilities}}$	+	X_1
2	Quick ratio	$\frac{\text{Current assets} - \text{Inventory}}{\text{Short – term liabilities}}$	+	X_2
3	Inventory Turnover Ratio	$\frac{\text{Cost of goods sold}}{\text{Average of Inventory}}$	+	X_3
4	Accounts Receivable Turnover	$\frac{\text{Revenue}}{\text{Average of Accounts Receivable}}$	+	X_4
5	Debt Ratio	$\frac{\text{Total liability}}{\text{Total Assets}}$	-	X_5
6	Bank loans	tens of billion dongs	-	X_6
7	ROA	$\frac{\text{Profit after taxes}}{\text{Total Assets}}$	+	X_7
8	ROE	$\frac{\text{Profit after taxes}}{\text{Owners' equity}}$	+	X_8
9	Manager Level	0: Under university	-	X_9
		1: After university	+	
10	Credit history	0: repayment in full and on time	+	X_{10}
		1: Repayment not on time	-	
11	Operational Year	0: Under three years	-	X_{11}
		1: After three years	+	
12	Business scale	0: Small and medium enterprises	-	X_{12}
		1: Big enterprises	+	

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$Ln(odds) = \beta_0 + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \beta_4X_4 + \beta_5X_5 + \beta_6X_6 + \beta_7X_7 + \beta_8X_8 + \beta_9X_9 + \beta_{10}X_{10} + \beta_{11}X_{11} + \beta_{12}X_{12}$

3.3. Data

The article using dataset of 210 observations is the information calculated based on the data collected from the financial statements of enterprise. SPSS software was used to clean data and using Maddala's Binary logistics regression model to find out individual impacting factors that affect the loan repayment ability of corporate customers.

3.4. Model test

- Wald Test

shows the correlation between the dependent variable and the independent variables in model are statistically significant with confidence interval over 99%.

- Testing the explanation level of model

Table 5: *Model Summary*

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	33.508[a]	0.531	0.885

Explanatory coefficient of model: R2 Nagelkerke = 0.885. This means that 88.5% variation of the dependent variable is explained by 12

Table 3: *Variables in the Equation*

Variables	*B*	*S.E.*	*Wald*	*df*	*Sig.*	*Exp(B)*
Current Ratio	4.293	1.613	7.084	1	0.008	73.161
Quick ratio	3.139	1.489	4.441	1	0.035	23.076
Inventory Turnover Ratio	2.370	1.051	5.090	1	0.024	10.702
Accounts Receivable Turnover	0.930	0.455	4.178	1	0.041	2.534
Debt Ratio	-2.349	1.134	4.292	1	0.038	0.095
Bank loans	-0.262	0.125	4.427	1	0.035	0.769
ROE	0.115	0.057	4.097	1	0.043	1.122
ROA	0.340	0.159	4.582	1	0.032	1.405
Manager Level	3.342	1.441	5.378	1	0.020	28.269
Operational Year	2.997	1.433	4.372	1	0.037	20.032
Credit History	-2.685	1.348	3.968	1	0.046	0.068
Business scale	2.365	1.183	4.001	1	0.045	10.648
Constant	-19.141	6.709	8.139	1	0.004	.000

Performing Binary Logistics regression analysis with SPSS (Sig <0.05), we get the following results:

From the results of Logistics regression analysis in Table 3, we see that "sig." of the all of independent variables are less than 0.05. So, all of them in the Binary logistics regression model have a correlation with the dependent variable. The statistical significance level of the above regression coefficients has a reliability of over 95%, the symbols of the regression coefficients are consistent with the initial hypothesis

- Omnibus Test

Based on the results of omnibus test of the model, we have sig <0.05 so the general model

independent variables in model, the rest for other factors

*- Testing the level of accurate prediction of model (*Table 6)

- In 36 respondents are unable to pay debts, the model is accurate forecasting 31 cases, model's correct rate is 86.1%

- In 174 respondents are able to pay debts, the model is the accurate forecasting 171 cases, model's

Table 4: *Omnibus Tests of model coefficients*

	Chi-square	*df*	*Sig.*
Step	**158.912**	**12**	**.000**
Block	**158.912**	**12**	**.000**
Model	**158.912**	**12**	**.000**

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correct rate is 98.3%.

The accurate forecast rate of overall model is 96.2%

- Testing the multi-collinearity phenomenon

The article is based on variance inflation factor (VIF) to detect multi-collinearity phenomenon (Table 7).

Table 6: *Classification table*[a]

Observed		Predicted		
		Loan repayment ability		Percentage Correct
		Inability to pay debts	Ability to pay debts	
Loan repayment ability	Inability to pay debts	31	5	86.1
	Ability to pay debts	3	171	98.3
Overall Percentage				96.2

Table 7: *Coefficients*[a]

Model	Unstandardized Coefficients		standardized Coefficients	t	Sig.	Collinearity Statistics	
	B	Std.Error	Beta			Tolerance	VIF
(Constant)	-0.110	0.129		-0.855	0.393		
Current Ratio	0.091	0.041	0.140	2.233	0.027	0.440	2.271
Quick ratio	0.030	0.040	0.046	0.754	0.451	0.459	2.178
Inventory Turnover Ratio	0.050	0.023	0.097	2.216	0.028	0.909	1.100
Accounts Receivabl Turnover	0.055	0.013	0.195	4.268	0.000	0.833	1.201
Debt Ratio	-0.256	0.059	-0.262	-4.340	0.000	0.476	2.102
Bank Loans	-0.003	0.002	-0.104	-1.690	0.093	0.459	2.180
ROE	0.002	0.002	0.101	1.296	0.196	0.285	3.504
ROA	0.001	0.002	0.032	0.562	0.575	0.543	1.841
Manager Level	0.235	0.057	0.199	4.116	0.000	0.746	1.340
Operational Year	0.127	0.054	0.118	2.353	0.020	0.695	1.440
Credit History	-0.019	0.036	-0.024	-0.516	0.606	0.773	1.294
Business scale	0.329	0.056	0.296	5.883	0.000	0.685	1.459
Constant	-19.141	6.709	8.139	1	0.004	.000	

Looking at the table 7, we see that the variance inflation factor (VIF) of variables are < 4, so there is no multicollinearity phenomenon.

4. Discussion

4.1. Credit risk warning model

Variables	B	S.E.	Wald	df	Sig.	Exp(B)
Current Ratio	4.293	1.613	7.084	1	0.008	73.161
Quick ratio	3.139	1.489	4.441	1	0.035	23.076
Inventory Turnover Ratio	2.370	1.051	5.090	1	0.024	10.702
Accounts Receivable Turnover	0.930	0.455	4.178	1	0.041	2.534
Debt Ratio	-2.349	1.134	4.292	1	0.038	0.095
Bank Loans	-0.262	0.125	4.427	1	0.035	0.769
ROE	0.115	0.057	4.097	1	0.043	1.122
ROA	0.340	0.159	4.582	1	0.032	1.405
Manager Level	3.342	1.441	5.378	1	0.020	28.269
Operational Year	2.997	1.433	4.372	1	0.037	20.032
Credit History	-2.685	1.348	3.968	1	0.046	0.068
Business scale	2.365	1.183	4.001	1	0.045	10.648
Constant	-19.141	6.709	8.139	1	0.004	.000

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The general logistic regression equation has the form:

Ln(odds) = $\beta_0 + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \beta_4X_4 + \beta_5X_5 + \beta_6X_6 + \beta_7X_7 + \beta_8X_8 + \beta_9X_9 + \beta_{10}X_{10} + \beta_{11}X_{11} + \beta_{12}X_{12}$

From the logistic regression analysis table, we can write the logistic equation in the economic direction as follows:

Ln(odds) = -19.141 + 4.293* X_1 + 3.139* X_2 + 2.370* X_3 + 0.930* X_4 - 2.349* X_5 - 0.262* X_6 + 0.115* X_7 + 0.340* X_8 + 3.342* X_9+ 2.997* X_{10}- 2.685* X_{11}+ 2.365* X_{12}

4.2. Analysis of regression results

4.2.1. Current ratio

B_1= 4.293, P_0 =10%, $e^{B_1} = e^{4.293} = 73.161$

$$\mathbf{P_1 = \frac{P_0 \times e^{B_1}}{1-P_0(1-e^{B_1})} = \frac{0.1 \times 73.161}{1-0.1(1-73.161)} = \frac{7.3161}{8.2161} = 0.89}$$

If the initial probability of repayment is 10%, when all other factors are unchanged, if the Current ratio of enterprise increases by 1 unit, the probability of repayment debt of that enterprise is 89% (increased to 79% compared to the initial probability of 10%).

4.2.2. Quick ratio

B_2= 3.139, P_0 =10%, $e^{B_2} = e^{3.139} = 23.076$

$$\mathbf{P_1 = \frac{P_0 \times e^{B_2}}{1-P_0(1-e^{B_2})} = \frac{0.1 \times 23.076}{1-0.1(1-23.076)} = \frac{2.3076}{3.2076} = 0.72}$$

If the initial probability of repayment is 10%, when all other factors are unchanged, if the Quick ratio of enterprise increases by 1 unit, the probability of repayment debt of that enterprise is 72% (increased to 62% compared to the initial probability of 10%).

4.2.3. Inventory Turnover Ratio

B_3= 2.370, P_0 =10%, $e^{B_3} = e^{2.370} = 10.702$

$$\mathbf{P_1 = \frac{P_0 \times e^{B_3}}{1-P_0(1-e^{B_3})} = \frac{0.1 \times 10.702}{1-0.1(1-10.702)} = \frac{1.0702}{1.9702} = 0.54}$$

If the initial probability of repayment is 10%, when all other factors are unchanged, if the Inventory Turnover Ratio of enterprise increases by 1 unit, the probability of repayment debt of that enterprise is 54% (increased to 44% compared to the initial probability of 10%).

4.2.4. Accounts Receivable Turnover

B_4= 0.930, P_0 =10%, $e^{B_4} = e^{0.930} = 2.534$

$$\mathbf{P_1 = \frac{P_0 \times e^{B_4}}{1-P_0(1-e^{B_4})} = \frac{0.1 \times 2.534}{1-0.1(1-2.534)} = \frac{0.2534}{1.1534} = 0.22}$$

If the initial probability of repayment is 10%, when all other factors are unchanged, if the Accounts Receivable Turnoveof enterprise increases by 1 unit, the probability of repayment debt of that enterprise is 22% (increased to 12% compared to the initial probability of 10%).

4.2.5. Debt Ratio

B_5= -2.349, P_0 =10%, $e^{B_5} = e^{(-2.349)} = 0.095$

$$\mathbf{P_1 = \frac{P_0 \times e^{B_5}}{1-P_0(1-e^{B_5})} = \frac{0.1 \times 0.095}{1-0.1(1-0.095)} = \frac{0.0095}{0.9095} = 0.01}$$

If the initial probability of repayment is 10%, when all other factors are unchanged, if the Debt Ratio of enterprise increases by 1 unit, the probability of repayment debt of that enterprise is 1% (decreased to 9% compared to the initial probability of 10%).

4.2.6. Bank Loans

B_6 = -0.262, P_0 =10%, $e^{B_6} = e^{0.262} = 0.769$

$$\mathbf{P_1 = \frac{P_0 \times e^{B_6}}{1-P_0(1-e^{B_6})} = \frac{0.1 \times 0.769}{1-0.1(1-0.769)} = \frac{0.0769}{0.9769} = 0.08}$$

If the initial probability of repayment is 10%, when all other factors are unchanged, if the Bank Loans of enterprise increases by 1 unit, the probability of repayment debt of that enterprise is 8% (decreased to 2% compared to the initial probability of 10%).

4.2.7. ROE

B_7= 0.115, P_0 =10%, $e^{B_7} = e^{0.115} = 1.122$

$$\mathbf{P_1 = \frac{P_0 \times e^{B_7}}{1-P_0(1-e^{B_7})} = \frac{0.1 \times 1.122}{1-0.1(1-1.122)} = \frac{0.1122}{1.0122} = 0.11}$$

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If the initial probability of repayment is 10%, when all other factors are unchanged, if the ROE of enterprise increases by 1 unit, the probability of repayment debt of that enterprise is 11% (increased to 1% compared to the initial probability of 10%).

4.2.8. ROA

B_8= 0.340, P_0 =10%, $e^{B_8} = e^{0.340} = 1.405$

$$P_1 = \frac{P_0 \times e^{B_8}}{1-P_0(1-e^{B_8})} = \frac{0.1 \times 1.405}{1-0.1(1-1.405)} = \frac{0.1405}{1.0405} = 0.14$$

If the initial probability of repayment is 10%, when all other factors are unchanged, if the ROA of enterprise increases by 1 unit, the probability of repayment debt of that enterprise is 14% (increased to 4% compared to the initial probability of 10%).

4.2.9. Manager Level

B_9= 3.342, P_0 =10%, $e^{B_9} = e^{3.342} = 28.269$

$$\mathbf{P_1 = \frac{P_0 \times e^{B_9}}{1-P_0(1-e^{B_9})} = \frac{0.1 \times 28.269}{1-0.1(1-28.269)} = \frac{2.8269}{3.7269} = 0.76}$$

If the initial probability of repayment is 10%, when all other factors are unchanged, if the Manager Level of enterprise increases by 1 level, the probability of repayment debt of that enterprise is 76% (increased to 66% compared to the initial probability of 10%).

4.2.10. Operational Year

B_{10}= 2.997, P_0 =10%, $e^{B_{10}} = e^{2.997} = 20.032$

$$\mathbf{P_1 = \frac{P_0 \times e^{B_{10}}}{1-P_0(1-e^{B_{10}})} = \frac{0.1 \times 20.032}{1-0.1(1-20.032)} = \frac{2.0032}{2.9032} = 0.69}$$

If the initial probability of repayment is 10%, when all other factors are unchanged, if the Operational Year of enterprise increases by 1 year, the probability of repayment debt of that enterprise is 69% (increased to 59% compared to the initial probability of 10%).

4.2.11. Credit history

B_{11}= -2.685, P_0 =10%, $e^{B_{11}} = e^{(-2.685)} = 0.068$

$$\mathbf{P_1 = \frac{P_0 \times e^{B_{11}}}{1-P_0(1-e^{B_{11}})} = \frac{0.1 \times 0.068}{1-0.1(1-0.068)} = \frac{0.0068}{2.9032} = 0.09}$$

If the initial probability of repayment is 10%, when all other factors are unchanged, if the enterprise has not got a good Credit history, the probability of repayment debt of that enterprise is 9% (decreased to 1% compared to the initial probability of 10%).

4.2.12. Business scale

B_{12}= 2.365, P_0 =10%, $e^{B_{12}} = e^{2.365} = 10.648$

$$\mathbf{P_1 = \frac{P_0 \times e^{B_{12}}}{1-P_0(1-e^{B_{12}})} = \frac{0.1 \times 10.648}{1-0.1(1-10.648)} = \frac{1.0648}{1.9648} = 0.54}$$

If the initial probability of repayment is 10%, when all other factors are unchanged, if the interprise has larger scale, the probability of repayment debt of that enterprise is 54% (increased to 44% compared to the initial probability of 10%).

4.3. Determining the influence of independent variables on loan repayment (Dependent)

5. Conclusion

Credit risk is the first prioritized factor to commercial banking systems. Therefore, building a suitable risk management standard will give competitive advantages to bank managers in the industry.

From results in this research, a credit risk warning model was suggested for managers based on financial impacting factors. In fact, the new model will focus and point out whether the corporate customers can maintain their solvency or not. Moreover, from the research, the most impacting factor to customer' loan repayment ability will be revealed for the consideration of banking managerial leaders. ◆

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Ordinal numbers	*variable names*	*B*	*EXP(B)*	*Initial probability* $P_0 = 10\%$ P_1	*Increase speed (Decrease) %*	*Influence level*
1	Current Ratio	4.293	**73.161**	89	**79**	1
2	Quick ratio	3.139	**23.076**	72	**62**	3
3	Inventory Turnover Ratio	2.370	**10.702**	54	**44**	5
4	Accounts Receivable Turnover	0.930	**2.534**	22	**12**	6
5	Debt Ratio	- 2.349	**0.095**	1	**-9**	7
6	Bank Loans	- 0.262	**0.769**	8	**-2**	9
7	ROE	0.115	**1.122**	11	**1**	10
8	ROA	0.340	**1.405**	14	**4**	8
9	Manager Level	3.342	**28.269**	76	**66**	2
10	Operational Year	2.997	**20.032**	69	**59**	4
11	Credit History	- 2.685	**0.068**	9	**-1**	10
12	Business scale	2.365	**10.648**	54	**44**	5

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Summary

Xuất phát từ tính cấp thiết của tình hình thực tế, các ngân hàng thương mại cần có một công cụ quản trị rủi ro tín dụng hữu hiệu để hạn chế rủi ro. Nhóm tác giả đã đi khảo sát, nghiên cứu và đề xuất bộ các yếu tố tác động đến khả năng trả nợ của khác hàng cá nhân và tiên hành khảo sát. Đê tài sử dụng bộ dữ liệu gồm 210 mẫu quan sát. Sử dụng phần mềm SPSS làm sạch dữ liệu và chạy mô hình dựa trên hồi quy Binary logistics của Maddala xuất bản năm 1984 để tìm ra tác động của từng yếu tố riêng biệt của khách hàng ảnh hưởng đến khả năng trả nợ của họ như thế nào. Nhóm tác giả cũng chỉ rõ thứ tự mức độ ảnh hưởng của từng nhân tố quyết định đến khả năng trả nợ của khách hàng cá nhân, từ đó giúp các nhà quản lý ngân hàng có cái nhìn trực quan tốt hơn để ra quyết định cho vay chính xác, hạn chế rủi ro.

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