

## **THE APPLICATION OF THE BINARY LOGISTIC MODEL: A CASE OF JOINT STOCK COMMERCIAL BANK FOR INVESTMENT AND DEVELOPMENT OF VIETNAM (BIDV) IN VINH LONG PROVINCE**

Mai Thanh Loan, Hung Vuong University Ho Chi Minh City (HVUH)

*Phan Du Thuy Anh, BIDV*

*Nguyen Quoc Uy, BIDV*

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**ABSTRACT:** *This study aims to estimate the factors affecting the probability of repayment of individual customers, corporate customers at BIDV in Vinh Long province. The sample data includes 403 individual customers and 160 corporate customers who selected from the BIDV's customer data set. The regression analysis results tested seven factors affecting the probability of debt repayment of individual customers with significance level 0.10 from 9 factors proposed. Besides, five factors affecting the probability of debt repayment of corporate customers with significance level 0.05 from 8 factors proposed.*

**KEYWORDS:** Binary logistic model, customers, Debt, BIDV, HVUH.

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### **INTRODUCTION**

Nowadays, there are many models that need to be predicted for the likelihood, for example if a new product is accepted or not, the borrower can pay the debt, whether the business goes bankrupt or not, whether or not the customer buys whether it is raining or not, the patient dies or not... Variables with two such expressions will be encoded into two values 0 and 1 and in this form are called binary variables. When the dependent variable is in binary form, it is not possible to analyze it with a regular regression because it will violate assumptions, it is easy to see that when the dependent variable has only two expressions it is not appropriate to assume that the residue has a normal distribution, but instead it has a binomial distribution, which will invalidate the statistics of tests in conventional regression. The above mentioned things, the researcher chosen topic “*The application of the binary logistic model: a case of Joint Stock Commercial Bank for Investment and Development of Vietnam (BIDV) in Vinh Long province*” as a paper. This paper helps BIDV managers who apply the research results for improving policy on the management of the customers’ debt better in the future.

### **LITERATURE REVIEW**

A binomial logistic regression (often referred to simply as logistic regression), predicts the probability that an observation falls into one of two categories of a dichotomous dependent variable based on one or more independent variables that can be either continuous or categorical. The theoretical basis for the proposed research model is the theory of commercial bank credit risk. The theoretical basis for data processing method is econometric theory of multivariate regression, Binary Logistic model. The experimental basis for the proposed research model is the previous

relevant studies, including 05 foreign research papers and 04 domestic research papers. Practical basis for the research paper and also the basis for applying research results is BIDV Vinh Long.

**Table 1: Summary of a number of studies related to the debt payment of individual customers**

No	Researchers	Number of studies	Factors affecting the probability of debt repayment of individual customers
1	Antwi và ctg (2012)	factors affecting the risk of defaulting on debt at AkuaPem bank in Ghana	- Loan form - Loans are guaranteed
2	<i>Munene &amp; Guyo (2013).</i>	Factors affecting the repayment capacity of people with loans in Kenya	- Business experience - Occupation - Number of business participants - Income
3	Pasha, C.A.M & Negese (2014)	Determining factors affecting borrowers' loan repayment performance at Sidama Microfinance Institute (SMFI).	- Age - Education - Loan size - Loan term - Number of dependents - Monitoring
4	<i>Theresa U. Anigbogu, PhD &amp; ctg (2014)</i>	The determinants of debt repayment by cooperating farmers in the Awka North LGA of Anambra state, Nigeria.	- Education level - Farm size - Loan application - Cost - Collateral
5	Tran The Sao (2017)	Factors affecting the ability to repay bank loans of farmers in Ben Luc district, Long An province.	- Education level - Cultivated land area - Non-agricultural income - Repayment term - Loan amount - Number of dependents

(Source: The researchers' collecting)

Table 1 showed that there are five studies related to the debt payment of individual customers. Antwi và ctg (2012), Munene & Guyo (2013), Pasha, C.A.M & Negese (2014), Theresa U. Anigbogu, PhD & ctg (2014) and Tran The Sao (2017). Five studies found out many various factors affecting the probability of debt repayment of individual customers. Factors include: Loan form, Business experience, Occupation, Number of business participants, Income, Age, Education, Loan size, Loan term, Education level...

Being able to pay debts on time < 10 days Y = 1 (Y is dependent variable)

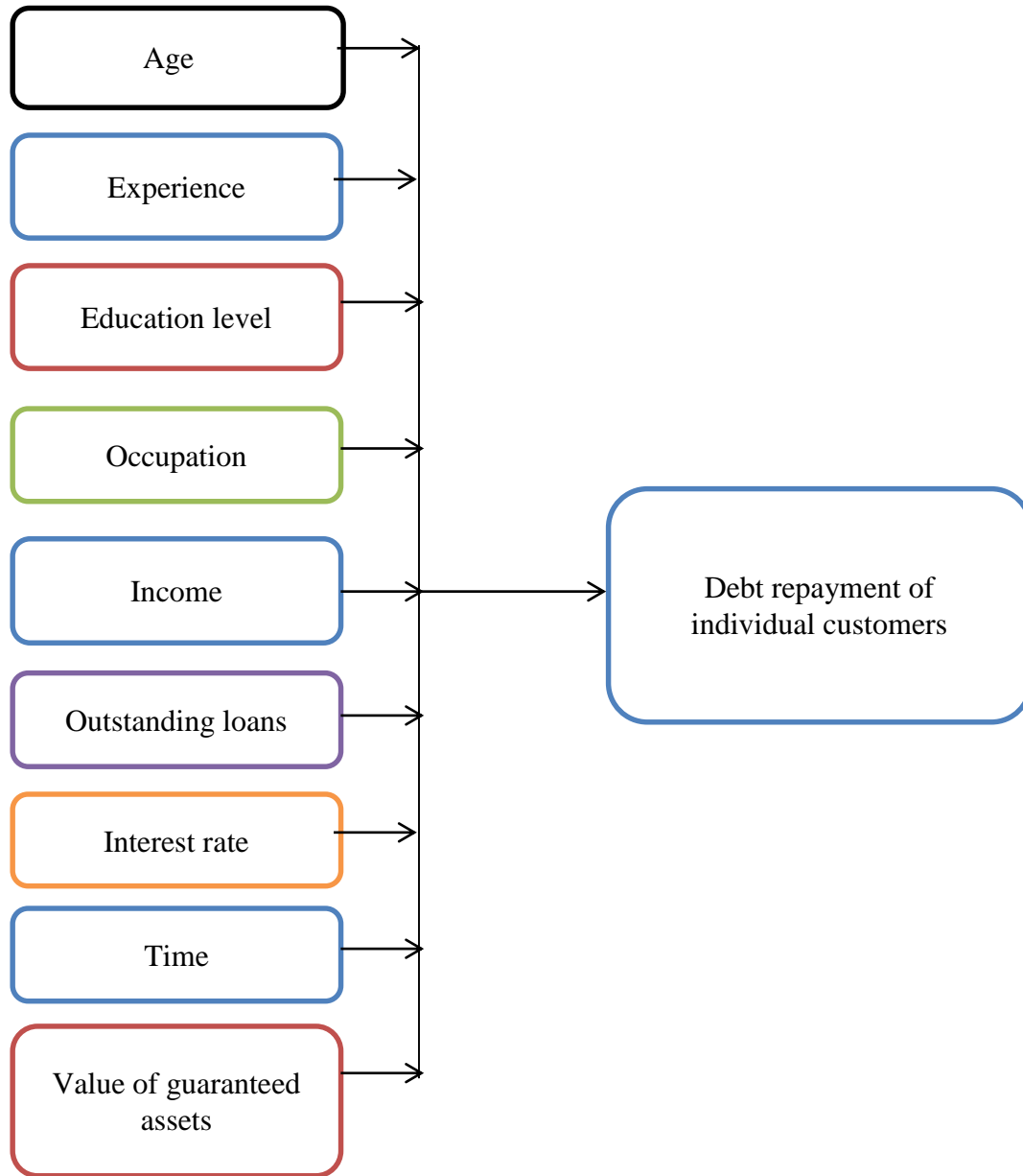
Being able to pay debts on time ≥ 10 days Y = 0 (Y is dependent variable)

Y: The Debt repayment of individual customers

Xi: Independent variables

Loan form, Business experience, Occupation, Number of business participants, Income, Age, Education, Loan size, Loan term, Education level... are independent variables.

Based the above mentioned thing, the researchers have the model figure 1 bellowed:



(Source: The researchers' collecting and proposed)

**Figure 1: Research model for factors affecting Debt repayment of individual customers at BIDV in Vinh Long province**

Figure 1 showed that there were nine factors affecting Debt repayment of individual customers at BIDV in Vinh Long province. All of factors are positive relationship with Debt repayment of individual customers at BIDV in Vinh Long province but interest rate is negative relationship with Debt repayment of individual customers. We can see the summary of hypothesis table 2 bellowed.

**Table 2: Summary of hypothesis for nine factors affecting Debt repayment of individual customers**

No.	Variable name	Code	Measured	Expected
1	Age	Tuoi	Number of age	+
2	Education level	TrinhDo	1: Under high school 2: High school 3: College 4: University	+
3	Experience	KinhNghiem	Number of experience	+
4	Occupation	Nganh	1: Agriculture 2: Others	Affected
5	Income	ThuNhap	Millions of VND	+
6	Time	ThoiGian	Month	+
7	Interest rate	LaiSuat	Year	-
8	Outstanding loans	DuNo	Month	+
9	Value of guaranteed assets	TSDB	Millions of VND	+

(Source: The researchers' collecting and proposed)

Table 2 showed that there were nine factors affecting Debt repayment of individual customers at BIDV in Vinh Long province.

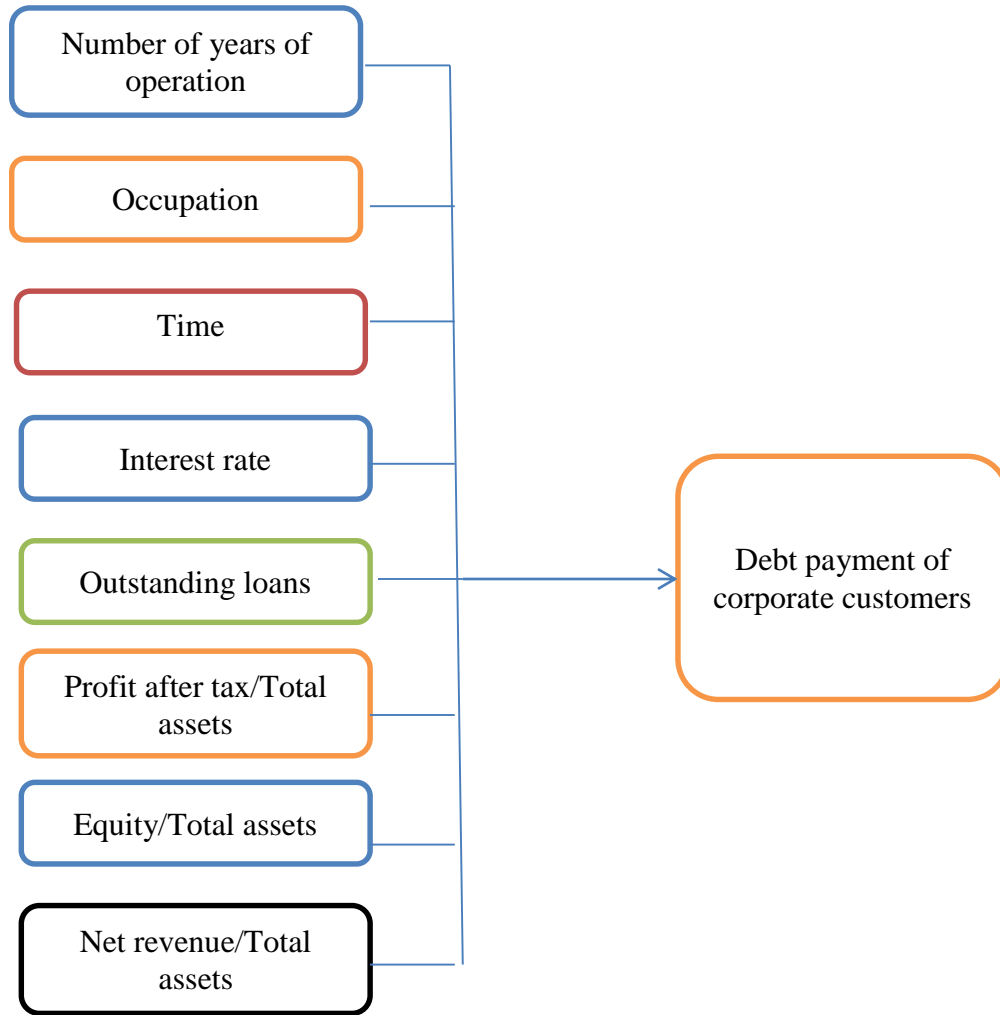
**Table 3: Summary of a number of studies related to the debt payment of corporate customers**

No	Researchers	Number of studies	Factors affecting the probability of debt repayment of corporate customers
1	Chiara Pederzoli, Costanza Torricelli (2010)	The model predicts the probability of debt repayment by businesses in Italy.	- Long-term debt/Total assets - Profit/Total assets - Revenue/Total assets - Equity/Total assets
2	Le Khuong Ninh and Lam Thi Bich Ngoc (2012)	Ability to repay bank loans of enterprises in Can Tho city	- Financial leverage - ROA - Cash flow
3	Hua Thi Hong Hoa (2016)	Factors affecting the ability to repay corporate customers at Agribank Vietnam - Dong Nai Branch.	- Loan period - Loan interest rate - Total outstanding loans - Profit after tax/Total assets - Net revenue/Total assets
4	Bui Van Trinh and Nguyen Tan Duy Quoc (2017)	Access to capital and ability to repay loans on time by enterprises in Can Tho city.	- Loan value - Loan history - Number of years of operation - ROA

(Source: The researchers' collecting and proposed)

Table 3 showed that there were four studies related to the debt payment of corporate customers. four studies include: Chiara Pederzoli, Costanza Torricelli (2010), Le Khuong Ninh

and Lam Thi Bich Ngoc (2012), Hua Thi Hong Hoa (2016) and Bui Van Trinh and Nguyen Tan Duy Quoc (2017). Based the above mentioned thing, the researchers have the model figure 2 bellowed:



(Source: The researchers' collecting and proposed)

**Figure 2: Research model for factors affecting Debt repayment of corporate customers at BIDV in Vinh Long province**

Figure 4 showed that there were eight factors affecting Debt repayment of corporate customers at BIDV in Vinh Long province. All of factors are positive relationship with Debt repayment of corporate customers at BIDV in Vinh Long province but interest rate is negative relationship with Debt repayment of individual customers. We can see the summary of hypothesis table 3 bellowed.

Y: The Debt repayment of corporate customers

Xi: Independent variables

**Table 4: Summary of hypothesis for eight factors affecting Debt repayment of corporate customers**

<i>No.</i>	<i>Variables</i>	<i>Measured</i>	<i>Explaining</i>	<i>Expected</i>
1	Number of years of operation (SONAM)	Year	Number of years of operation at enterprises	+
2	Occupation	Construction = 1 Others =0	Enterprises operating in the construction industry	Affected
3	Time (THOIGIAN)	Month	Average loan time of corporate customers for each specific credit product	+
4	Interest rate (LAISUAT)	%/ year	Average interest rate of corporate customers at BIDV	-
5	Outstanding loans (DUNO)	Millions of VND	Total outstanding loans of corporate customers at the time of assessment of debt repayment capability	+
6	LNST	Profit after tax/Total assets	From financial statements provided by corporate customers during the assessment year	+
7	VONCSH	Equity/Total assets	From financial statements provided by corporate customers during the assessment year	+
8	DTT	Net revenue/Total assets	From financial statements provided by corporate customers during the assessment year	+

(Source: The researchers' collecting and proposed)

Table 4 showed that there were eight factors affecting Debt repayment of corporate customers at BIDV in Vinh Long province.

## **METHODS OF RESEARCH**

This research is done through two steps: Qualitative research and Quantitative research.

Qualitative research: It is a kind of research used to adjust, modify and unify observing variables to measure the research concept. This research was done by discussing with individuals

representing members of board of directors BIDV to find out about the viewpoints and the business characteristics of enterprises in the area of research. The purpose of qualitative research is inspecting the scale and eliminating unsuitable variables as well as supplementing new significant variables for the research in accordance with specific characteristics of business in the area of research. Quantitative research: This study is a quantitative paper that is combined with qualitative research in the proposed research model, suggesting the implication of management from model results. Application model is a Binary Logistic regression model by Donald R. Cooper and Pamela S. Schindler (2006), in the form of:

$$Y_i = \text{Log} (P_i / (1-P_i)) = \beta_1 + \beta_2 X_{2i} + \dots + \beta_k X_{ki}$$

Note:

Y: dependent variable (Debt repayment ability)

X<sub>i</sub>: independent variable i (Factors affecting debt payment ability)

β<sub>0</sub>: Intercept factor.

β<sub>i</sub>: Regression coefficient i (i =  $\overline{1, k}$ )

The overall sample of individual customers for the study is selected from a general overview of personal customer data. The sample data includes 403 individual customers and 160 corporate customers who selected from the BIDV's customer data set. Data having a credit relationship with the bank for more than 1 year for the purpose of borrowing business joint. Besides, the method of selecting the system in a straight line with regular intervals is the ratio of the overall sample to the overall. Enterprise customer data for research is all bank customer business data by William H. Greene (2002). Data is processed on Stata 12.0

## RESEARCH RESULTS

**Table 5: Correlation matrix of factors affecting Debt repayment of individual customers**

	KNTN	Tuoi	TrinhDo	Ki.Nghiem	Nganh	ThuNhap	ThoiGian	LaiSuat	DuNo	TSDB
KNTN	1.0000									
Tuoi	-0.078	1.00								
TrinhDo	0.4101	-0.223	1.00							
Ki.Nghiem	-0.012	0.2305	0.1525	1.00						
Nganh	-0.021	0.2395	-0.276	-0.084	1.00					
ThuNhap	0.2988	-0.048	0.4135	0.1593	-0.317	1.00				
ThoiGian	0.0535	0.0229	0.0156	-0.111	-0.114	-0.133	1.00			
LaiSuat	-0.227	0.1142	-0.229	-0.112	0.241	-0.363	0.4244	1.00		
DuNo	0.036	0.0097	0.2771	0.0572	-0.205	0.6935	-0.1403	-0.284	1.00	
TSDB	0.0934	0.0067	0.3255	0.0753	-0.204	0.6409	-0.067	-0.259	0.778	1.00

(Source: The researchers' processing Stata 12.0)

Table 5 showed that there are the correlation matrix of factors affecting Debt repayment of individual customers with significance level 0.05.

**Table 6: Correlation matrix of factors affecting Debt repayment of corporate customers**

	KNTN	Sonam	Nganh	Thoigian	Laisuat	Duno	LNST	V.CSH	DTT
KNTN	1								
Sonam	-0.007	1							
Nganh	0.159	0.112	1						
Thoigian	-0.099	-0.053	-0.089	1					
Laisuat	-0.378	-0.152	-0.141	0.654	1				
Duno	-0.283	0.182	0.0571	0.115	0.099	1			
LNST	0.400	-0.018	-0.017	-0.108	-0.295	-0.092	1		
V.CSH	0.087	-0.144	-0.071	-0.065	-0.076	-0.247	0.124	1	
DTT	0.382	-0.002	-0.292	-0.184	-0.322	-0.151	0.345	-0.027	1

(Source: The researchers' processing Stata 12.0)

Table 6 showed that there are the correlation matrix of factors affecting Debt repayment of corporate customers with significance level 0.05.

**Table 7: The summary output of factors affecting Debt repayment of individual customers**

Logistic regression		Number of obs	=	403		
		LR chi2(7)	=	293.78		
		Prob > chi2	=	0		
Log likelihood = -78.902802		Pseudo R2	=	0.6506		
Variables	coefficient	Standard error	z	P>z	Lower	Upper
Trinhdo	1.65085	0.40357	4.09000	0.00000	0.85986	2.44184
Nganh	2.13001	0.48311	4.41000	0.00000	1.18313	3.07690
Thunhap	0.91826	0.12057	7.62000	0.00000	0.68196	1.15457
Thoigian	0.07074	0.02184	3.24000	0.00100	0.02793	0.11355
Laisuat	-29.98820	18.18041	-1.65000	0.09900	-65.62116	5.64475
Duno	-0.00949	0.00209	-4.54000	0.00000	-0.01358	-0.0054
TSDDB	0.00461	0.00200	2.30000	0.02100	0.00068	0.00854
_cons	-4.86423	1.94437	-2.50000	0.01200	-8.67513	-1.0533

(Source: The researchers' processing Stata 12.0)

Table 7 showed that the factors affecting Debt repayment of individual customers with significance level 0.10. Besides, research result explained by 7 independent variables of the model with significance level 0.10. Seven variables sorting: Interest rate, Occupation, Education level, Income, Time, Outstanding loans, Value of guaranteed assets.



**Table 8: The summary output of factors affecting Debt repayment of corporate customers**

		Number of obs	160			
		LR chi2(7) =	80.27			
Logistic regression		Prob > chi2 =	0.0000			
		Pseudo R2 =	0.395			
Variables	coefficient	Standard error	z	P>z	Lower	Upper
Nganh	1.40115	0.483096	2.9	0.004	0.4543	2.348
Thoigian	0.0298454	0.012707	2.35	0.019	0.004941	0.05475
Laisuat	-32.55027	15.25451	-2.13	0.033	-62.4486	-2.65198
Duno	-0.0000287	1.53E-05	-1.87	0.061	-5.9E-05	1.32E-06
LNST	11.90316	5.376882	2.21	0.027	1.364666	22.44165
DTT	0.7385921	0.276853	2.67	0.008	0.195971	1.281213
_cons	1.19321	1.40517	0.85	0.396	-1.56087	3.947292

(Source: The researchers' processing Stata 12.0)

Table 8 showed that factors affecting Debt repayment of corporate customers with significance level 0.05. Besides, research result explained by 5 independent variables of the model with significance level 0.05. Five variables sorting: Interest rate, Profit after tax/Total assets, Occupation, Net revenue/Total assets and Time.

**Table 9: The forecasting of the Debt repayment of individual customers**

Model VCE: OIM, Average marginal effects, Number of obs = 403						
Variables	Delta-method		z	P > z	Lower	Upper
	Prob	Standard error				
Trinhdo	0.09850	0.02164	4.55000	0.00000	0.05609	0.14091
Nganh	0.12710	0.02491	5.10000	0.00000	0.07827	0.17592
Thunhap	0.05479	0.00325	16.87000	0.00000	0.04842	0.06116
Thoigian	0.00422	0.00122	3.47000	0.00100	0.00183	0.00661
Laisuat	-1.78936	1.06894	-1.67000	0.09400	-3.88444	0.30572
Duno	-0.00057	0.00011	-5.36000	0.00000	-0.00077	-0.00036
TSDB	0.00028	0.00012	2.39000	0.01700	0.00005	0.00050

(Source: The researchers' processing Stata 12.0)

Table 9 showed that the forecasting of the Debt repayment of individual customers with significance level 0.05.

**Table 10: The forecasting of the Debt repayment of corporate customers**

Model VCE: OIM Average marginal effects, Number of obs = 160						
Delta-method						
Variables	Prob	Standard error	z	P > z	Lower	Upper
Nganh	0.1723054	0.052737	3.27	0.001	0.0689435	0.275667
Thoigian	0.0036702	0.00146	2.51	0.012	0.000808	0.006533
Laisuat	-4.002847	1.762473	-2.27	0.023	-7.45723	-0.54846
Duno	-3.53E-06	1.80E-06	-1.96	0.05	-7.06E-06	5.64E-09
LNST	1.463783	0.62448	2.34	0.019	0.2398237	2.687742
DTT	0.0908278	0.031765	2.86	0.004	0.028569	0.153087

(Source: The researchers' processing Stata 12.0)

Table 10 showed that the forecasting of the Debt repayment of corporate customers with significance level 0.05.

## CONCLUSIONS AND MANAGERIAL IMPLICATIONS

### *Conclusions*

Based on the findings of this study, the following conclusions were drawn. Chi-Square testing of model suitability meets inspection standards, for conclusions:

1. R square ( $R^2$ ) = 65.1%: reflecting 65.1% of fluctuations in timely repayment capacity of individual customers in BIDV Vinh Long explained by 7 independent variables of the model with significance level 0.10. Seven variables sorting: Interest rate, Occupation, Education level, Income, Time, Outstanding loans, Value of guaranteed assets.

2. R square ( $R^2$ ) = 39.5%: reflecting 39.5% of fluctuations in timely repayment capability of corporate customers of BIDV Vinh Long explained by 5 independent variables of the model with significance level 0.05. Five variables sorting: Interest rate, Profit after tax/Total assets, Occupation, Net revenue/Total assets and Time.

According to the signs that identify the multicollinearity phenomenon, Based (VIF), for the conclusion: (1) There are no signs of multicollinearity between the independent variables in the model factors affecting the ability to repay on time of individual customers at BIDV Vinh Long. (2) There are no signs of multicollinearity between independent variables in the model factors affecting the ability to pay debts on time by corporate customers at BIDV Vinh Long.

### *Managerial implications*

Based on the findings and conclusions about the model. Factors affecting Debt repayment of individual customers at BIDV in Vinh Long province. The following recommendation are suggested: (1) for variables with no statistical significance (Age, Experience): in which, turning Age has a conclusive with most of the previous research results. While for the Experience variable, previous studies have different conclusions. On the other hand, compared with practice, managers with the role of experts discuss after research results. Researchers think that the age and experience of individual business borrowers have an impact on the ability of repayment of customer. Since

then, according to the authors of this paper, the factor of experience may be the variable that needs to be further verified in subsequent studies. (2) for statistically significant variables (Interest rate, Occupation, Education level, Income, Time, Outstanding loans, Value of guaranteed assets). Most of the above variables are consistent with previous studies. There are two variables to discuss: Interest Rate and Outstanding loans. (3) Interest rate: Regression coefficient is very high and correlates negatively with the ability to repay on time by individual customers. This is similar to previous research results. At the same time, if contacting management practices; Experts assess that most customers who cannot pay their debts have high interest rates, even borrowers with interest rates of 13-18% per year, especially in 2010-2012. Besides, the average interest rate is stable about 10%, the preferential interest rate is 6.5%, the overdue debt has decreased significantly. (4) Outstanding loans: It is negatively correlated with the ability to pay on time by corporate customers. This is similar to previous research results. At the same time, if contacting management practices; Especially in Vinh Long, in the field of water transport as well as in traditional sectors of Vinh Long such as brick production, export ceramics are strongly influenced by the fluctuations of domestic and foreign markets... In addition, individual customers borrow from production and business often have household size, when the outstanding debt increases, the scale of operation increases, the business management is not tight, easily leading to the possibility repayment on time for the bank.

Based on the findings and conclusions about the model. Factors affecting Debt repayment of corporate customers at BIDV in Vinh Long province. The following recommendation are suggested: (1) for non-statistically significant variables (Number of years in the construction industry, Equity ratio on total assets): this is the difference between theory and empirical results from the model. research. (2) for statistically significant variables (Occupation, Time, Interest rate, Profit after tax on total assets, Net revenue on total assets): most of the above variables have results consistent with previous studies.

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