Journal of Trade Science

ISSN 1859-3666

Volume 7 Number 2 June 2019

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Journal of Trade Science 7:2 (2019) 62 - 72

ISSN 1859-3666

BANK CONSUMER CREDIT SCORING MODEL IN VIETNAM

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Riceved: *26th March 2019* ***Rivised:*** *14th April 2019* ***Approved:*** *19th April 2019*

As many Vietnamese banks are moving towards consumer credit and personal lending, this paper aims to provide a consumer credit scoring model that can be applied to Vietnamese banks. The article uses the FICO system while taking into account the situation of Vietnam. It also aims at helping consumers calculate their credit score in a simple way.

Keywords: *Consumer credit, credit scoring, default.*

1. Introduction

Consumer banking market in Vietnam is growing and changing rapidly in both quality and quantity. On the other hand, since consumer credit is considered as an infant service in Vietnam's banking and finance market, available retail banking products are still limited.

Besides, the consumer credit rating system in Vietnam remained very much underdeveloped. This causes many banks remaining hesitant to promote consumer lending products due to the risk they have to suffer. Firstly, lack of reliable information makes it difficult for credit organizations to provide credit in general and carry out the credit scoring process. Although there is potential for appearance of some international reporting companies such as Trans Union in Vietnam, the establishment and development of these companies are just on the very first steps of the long road. Thus, data used for credit scoring process is mostly collected from the appraisal process of credit officers. In other words, this method is mainly based on a customer's self declaration, which may cause risks to the bank as the customer may hide their existing negative credit information, especially their bad debts. Secondly, the internal credit rating system for consumer credit of most Vietnamese commercial banks poses several limitations. The credit assessment system is constructed on the basis of a qualitative method where scores and weights of each variable are not the result of a statistical approach but relied on experience and judgment of credit officer. Furthermore, the bank cannot determine the degree of contribution of each qualitative variable (parameters) to the total scores due to the same weight (10% for each non-financial factor). More importantly, when this system is applied, probability of default cannot be estimated.

ISSN 1859-3666

As suggested above, so as to promote the development of consumer credit industry in Vietnam, there is a need for the significant improvements in the availability of credit information as well as the quality of internal credit ratings system. More advanced methodology and approach to gradually establish the Vietnamese consumer credit model should be applied, which is the reason for the development of a Consumer Credit Scoring model in Vietnam.

Credit scoring model was first introduced in the 1940s and over the years had evolved and developed significantly due to the increased competition in the financial industry together with advances in information technology. Credit scoring has numerous benefits not only to lenders but also to borrowers. From lenders' perspective, credit scoring helps to increase the speed and consistency of the loan application process and allows the automation of the lending process. Furthermore, it protects the interest of borrowers because credit score helps to reduce discrimination as credit scoring models provide an objective analysis of a consumer's creditworthiness. Because of its merits, this method is widely applied in the world. Nevertheless, the model has not been deeply investigated in Vietnam.

As suggested above, the main purpose of this paper is to apply and develop a more advanced credit scoring model for consumer loans. In the first step, the MDA method and SPSS software were employed to identify key variables that should be taken into account when constructing credit consumer model in Vietnam. Subsequently, the new model in which key variables were included was generated on the basis of SPSS results. This model is applicable to calculate Z-score, and then determine the probability of default.

The following section of this paper discusses the literature review on credit scoring model especially for Vietnam. The third part will concern the development of consumer credit scoring model, the next part will summarize two models, estimate sample default probability and the last section is conclusion.

2. Literature review

Discriminant analysis has been the most widely used techniques for building score-cards in the world. In 1936, Fisher introduced the idea of discriminating between groups in a population which examined the distinguishing ability of groups in a plant population based on various measured characteristics (specifically, between two species of iris by using measurements of the physical size of the plants). After that, in 1941, Durand, who was working on a research project for the US National Bureau of Economic Research, realized that Fisher's discriminant analysis could be used to differentiate between good and bad loans. In more details, he wanted to identify which parameters lenders found important and which characteristics were statistically significant. In his study, he presented a score-based system that could be used for the classification of the creditworthiness of each loan applicant for purchasing a second-hand car. The most important variables in his examination were as follows: age, gender, residence, profession, industry, job stability, bank account, and home ownership.

There have been only a few studies in Vietnam covering the subject of credit scorings in general and consumer credit scoring models in particular. In terms of credit scoring model for corporate credit, two thesis papers conducted by Nguyen and Dao (2009) and Dao (2010) from Faculty of Management and Tourism, Hanoi University, have provided insightful knowledge of Altman's Z-score

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model as well as and its applications in developing a more advanced credit scoring model. Furthermore, the methodology employed in two previous papers has established a solid foundation for the author to construct Credit Scoring Model for consumer credits. Specifically both of these papers focused on the same topic of Credit Scoring Model for Vietnamese non-manufacturing firms using disciminant analysis.Another point to note is that the author constructed the model using Z-score to calibrate the probability of default (PD), and then based on the Standard & Poor's information to propose ratings to Vietnamese non-manufacturing companies. The discussion on the establishment of relationship between Z-score, probability of default and ratings as well as the transition matrix might take contribution to enhance Vietnamese credit rating system.

Concerning the credit scoring model for consumer credit, one of the most well-known research paper was conducted by Dinh and Kleimeier (2007), covering the topic of establishment of Credit Scoring Model for Vietnam's Retail Market. All retail loans that were outstanding on a given day in 2005 were extracted from the database of Vietnamese commercial banks and then 22 variables were initially selected including 9 quantitative and 13 qualitative variables. Moreover, the sample of 56307 among which 798 are in default. They then used forward stepwise selection to select among 22 variables. Applying stepwise methods, 16 variables were included in the model. The paper addressed the lack of information on retail credit scoring by identifying which borrower characteristics a bank needed to collect. The most important predictors they found were time with bank, followed by gender, number of loans, and loan duration. Dinh and Kleimeier (2007) suggested companies to update their CSMs regularly to respond to the economic changes.

3. Consumer Credit Scoring for Vietnamese banks

3.1. Data collection and variables coding

Credit scoring is usually applied for assessing the creditworthiness of the loan applicants; as bankers will base on this score to make credit-granting decision. However, due to the fact that it is very difficult to collect the data directly from loan applicants, the researcher might find it impossible to construct a sample of loans. Therefore, a proxy sample of loan applicants was constructed by using consumer loans which have been already granted by banks. The main purpose of this research paper is to develop a consumer credit scoring model for evaluating the loan applications as well as for loan loss provision purpose, especially for existing loans. However, the result can also be applied in loan assessment in general.

As suggested above, in order to develop the model, 200 consumer loans that were currently outstanding were randomly selected from the database of five state-owned commercial banks in Vietnam. Nevertheless, due to the discrepancies of the data, only 122 loan applicants were chosen. Subsequently, loan amount was used as proxy to classify the borrowers into two different groups. The reason is that applicants who have higher scores are more likely to borrow larger loan amount. Distinction is also drawn for different kinds of loans such as real estate and car. Besides, expert interviews were conducted to make necessary adjustments in group classification.

Firstly, several variables were carefully chosen on the basis of: the list of commonly used variables for developing countries in research papers of

ISSN 1859-3666
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Crook's (1992), Vigono's (1993) and Stefanie Kleimeier (2005). The expert knowledge approach and the information availability are also taken into consideration. After that, six quantitative and four qualitative variables were selected. Secondly, in terms of qualitative variables, instead of using dummy variables, the rating scale from 10 (highest) and 0 (lowest) was applied, which is based on the principle: the better characteristics, the higher assigned scores (code) the loan applicant will receive. The variable coding is partially based on the principles suggested by Peter S. Rose (2008) (See Appendix A1).

3.2. Test of all 10 variables in SPSS

As mentioned above, Consumer Credit Scoring models are commonly structured along the lines of Altman's Z-score models. In the first step, discriminant analysis and the use of SPSS software were employed to examine the discriminating power of each given variable. In other words, this statistical technique helps researchers to identify which variables needed to be included in credit consumer model.

After strictly following the test procedure, the outcomes of SPSS is generated. First of all, in the table "Tests of Equality of Group Means" the results of univariate ANOVA's, carried out for each independent variable, are presented. Five out of variables including Edu (Education), Job (Occupation), Revenue I (Annual Personal Income), Dependant Nb (Number of Dependants) and Account are statistically significant since they all have significance level of lower than 5%. This is in parallel with the result of Wilks' Lambda. The lower Wilks' Lambda of an independent variable is, the more powerful that variable is in the discriminant model. Five variables which are statistically significant also have lowest Wilks' Lambda in the ascending order: Revenue I, Account, Job, Dependant Nb, and Edu.

An eigenvalue of 1.3889 indicates the proportion of variance explained, so a large eigenvalue is associated with a strong function. Therefore, the value of 1.388 indicates that there is a relatively high percentage of variances explained in the dependent variable, thus revealing a relatively strong discriminatory power of the function. This is also illustrated by the result of Wilks' Lambda which is the proportion of the total variance in the discriminant scores not explained by differences among groups. A lambda of 1.00 occurs when observed group means are equal (all the variances are explained by factors other than difference between those means), while a small lambda occurs when within-group variability is small as compared to the total variability. The Wilks' Lambda of 0.4186 has a significant value (Sig. = 0.000), thus, the group means appear to be different.

Discriminant test with ten variables discovers that nine "Top" and four "Bottom" group are misplaced by those ten variables equivalent to 6.55% type I and 14.75% type II errors happening. Therefore, 89.3% of originally grouped cases are correctly classified on average (See Appendix A2).

In short, the most striking feature to note is that five out of variables, including Edu, Job, Revenue I, Dependant Nb and Account play an important role in differentiating two groups as they all have significance level of lower than 5%. Moreover, Revenue I is the variable contributing the most to the model's discriminating power with the highest F value of 86.26. Furthermore, the remaining variables consisting of Age, YearWork, YearResi, YWBank and ResiStatus are statistically insignificant variables with very low F-values. Hence, with the aim to developing a more advanced Consumer Credit Scoring model, five variables with the highest predicting power will be put as independent variables.

3.3. Test of the five most significant

On the basis of test procedures applied and the result of the previous test, five variables doing the best overall job in discriminating the groups are put into DA in SPSS independent variable box.

The table of group statistics illustrates the differences in the mean of each individual financial ratio. Noticeably, the biggest inequality between two groups is certainly shown in RevenI (Annual personal income) which has strongest influence on the prediction model. In more details, the annual personal income of those who are classified in Group 1 is approximately 4 times higher than those coming from Group 2. Ranking the next in the discriminant power are Account, Job, Edu respectively which show higher figures for Group 2 than Group 1. In contrast, understandably, those loan applicants from Group 2 have fewer dependants than those of Group 1. (See Appendix A3).

The difference in the individual variable mean is obviously illustrated by Wilks' lambda value, F test and the significance levels. All 5 variables are significant under the level lower than 5%, implying there are significant differences among these variables between groups. Generally, on univariate level, all of the ratios indicate higher values for the "Top" loan applicants (See Appendix A4).

Scaled vector is employed "to determine the relative contribution of each variable to the total discriminating power of the final function and the interaction between two factors" (Altman, 1968). The relevant statistical figure in this test is observed as scaled vector which is computed according to the formula below:

Scaled vector = Std. Deviation * Variable's coefficient

The result of Scaled vector is aligned with the value of F-test. It indicates that two variables RevenI (mill) and Account contribute the most to the predictive function. (See Appendix A5).

As mentioned above, the Eigenvalue illustrates the proportion of variance in the dependent variable that can be explained by the independent variables. It is clear to note that the eigenvalue of 0.998 which is close to 1 means that almost all of the variance in the discriminant scores can be attributed to group differences.

4. Model Formulation

Following the methodology for developing Credit Scoring Model for consumer credit based on the Altman's (1968) Z - score model, the functions will be in the form of:

Z = W'X = Wj1 Xj2 +…+Wk Xk

where: Z = Overall Index, X1… Xj = Independent Variables, w1 … wj = Discriminant Coefficients (the coefficient of the kth variable)

Coefficients in two forms: Unstandardized form (with a constant term) and Standardized form (without a constant value) can be indicated in the table "Canonical Discriminant Function Coefficients".

Unstandardized form

Based on the result of SPSS, the unstandardized Z-score model applied for consumer credit in Vietnam is as follows:

Z = 0.2256X1 + 0.004083 X2 + 0.0055X3 - 0.3004X4 + 0.1318X5 – 3.3022(1)

where: X1 = Edu; X2 = Job; X3 = RevenI (million); X4 = DependantNb; X5 = Account

As shown in the Equation 1, the highest coefficient's magnitude is Edu (X1) despite lower value of F-test as compared to others. If the ratio increases by

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one unit, the score positively changes by 0.2256. The variable DepdendantNb (X4), in contrast, has negative relationship with the applicant's score by 0.3004 times. The constant of (-3.3022) indicates when all the independent variables are zero, the score will be -3.3022 which sounds reasonable.

Regarding unstandardized form, the cutoff point for discriminant model is determined as follows:

$$C_{cutoff} = \frac{Z_1 * N_1 + Z_2 * N_2}{N_1 + N_2} \quad \textbf{(2)}$$

where: Z1 is the average of Group 1's Z-scores calculated using formula (1)

N1 is the number of observations in Group 1

Z2 is the average of Group 2's Z-scores calculated using formula (1)

N2 is the number of observations in Group 2

With the aim to checking the validity of the value of Group centroid, the mean discriminant Z-scores for two different groups are calculated (See Appendix A7), which equal to (-0.992) and 0.992 for Group 1 and Group 2, respectively. They are in the same value but with opposite sign.

After that, applying the Equation 2, the cutoff point would be zero because the means of Unstandardized Z-score for two groups are equal in terms of absolute value but have the opposite sign (= (0.992*61-0.992*61)/(61+61) = 0). On the basis of this cutoff point, it is obviously seen from two tables in Appendix A6 that two applicants from Group 1 and eleven ones classified by Group 2 are misplaced, which is exactly the result generated from SPSS (See Appendix A6)

Standardized form

The standardized function can be written as follows:

Z = 0.2453X1 + 0.0754X2 + 0.8148X3 - 0.2412X4 + 0.4011X5 (3)

where X1 = Edu; X2 = Job; X3 = RevenI (million); X4 = DependantNb; X5 = Account

As can been seen from the table in Appendix A7, unlike unstandardized form, RevenI (X3) has the highest coefficient, in line with high F-test and Scaled Vector results. On the contrary, Job (X2) is the least powerful variable with lowest coefficient.

Subsequently, the cutoff point is determined by applying the Equation 2 = (286*61+82*61)/(61+61) = 184. As a result, no loan applicant from Group 1 but 20 belonging to Group 2 are misplaced, which represents 84% accuracy of prediction model using Standardized form. This figure is lower than that of classification result by SPSS (89.4%) (See Appendix A8).

Calibration of Default Probability of Z-score

Based on the secondary researches which have been carried out by various authors in the world, this paper will now turn into mapping Z-scores derived by the new model to probability of default (PD) and credit ratings. According to the research paper conducted by Dr. Stefanie Kleimeier (2006), a probability of default (PD) is determined by applying the following formula:

$$PD = \frac{1}{1+e^{-z}} \quad (4)$$

where: PD is the probability of default, Z is the Z-score (the higher the score, the better), e = 2,71828

However, the results calculated basing on the above equation cause very high default probability of domestic loan applicants. Thus, following the research and suggestion of Dr. Dao, Hanoi University, for the calibration from Credit Scoring and Probability of Default, the above equation is adjusted into:

$$PD = \frac{1}{1+e^{-Z}*20} \quad (5)$$

Applying Equation 4.2 to the sample of 122 Vietnamese consumers, the the probability of default are obtained.

It is realized that almost all of the loan applicants from Group 1 have higher probability of default than those of Group 2. Moreover, the result seems really reasonable and reliable as there are 11 applicants classified in Group 2 with high probability of default (11 borrowers are misplaced). A total of 13 loan applicants are incorrectly classified, hence the accuracy rate is 89,34%.

5. Conclusion

In this paper, overview of the development of Consumer Credit Scoring in the world in general and in Vietnam in particular will be briefly presented. Subsequently, literature review provides the background knowledge of credit scoring and well-known credit scoring methodologies. Data collection and handling processes carried out on the basis of these assumptions are noted before putting financial ratio into DA of SPSS to produce statistical results. Initially, discriminant analysis with ten independent variables is conducted to test the discriminating power of those variables in loan classification. The test finds out five most significant discriminators which are then utilized one more time in the SPSS to generate the final equation. There are two groups of coefficients, standardized and unstandardized ones. The unstandardized function is described as follows:

$$Z = 0.2256X1 + 0.0483X2 + 0.0055X3 - 0.3004X4 + 0.1318704X5 - 3.3022$$

where X1 = Edu; X2 = Job; X3 = RevenI (million); X4 = DependantNb; X5 = Account

One of the key findings is that 84.93% of the 122 loan applicants are correctly classified with the unstandardized function. The centroid or mean of the score of Group 1 and Group 2 is equal to 0.992 but in the opposite signs. The standardized one is presented below:

$$Z = 0.245X1 + 0.0754X2 + 0.81480X3 - 0.24127X4 + 0.4011X5$$

As mentioned above in the Classification result, the unstandardized form has been proved to be more powerful than the Standardized one. However, both of them have performed a relatively high level of accuracy in group classification. After that, the probability of default is calculated on the basis of unstandardized scores.

In summary, even though there are several unavoidable drawbacks, the newly developed scoring are still meaningful and useful for lenders in terms of accurately assessing the borrowers' creditworthiness, thus being able to reduce credit losses. At the minimum level, the paper has provided readers with the methodologies and approaches to develop an advanced credit scoring model with high level of accuracy, applicability and feasibility to predict the creditworthiness of the loan applicants.◆

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Appendix

A1: Qualitative Variables Coding

Variables	Categories	Code
Education (Edu)	Ph.D, and Master graduate	10
	Post graduate	9
	University graduate	8
	College graduate	7
	Vocational school graduate	6
	High school graduate	5
	Less than high school	0
Occupation (Job)	Professional executive (Director, Deputy Director, Chief Accountant)	10
	Professional executive at lower level (Head/Vice Head of Department), Architecture	9
	Entrepreneur (businessman), banker, skilled worker	8
	Clerical workers	7
	Students	5
	Unskilled workers	4
	Part-time workers	2
	Retiree	0
Residential Status (ResiStatus)	Home owner	10
	Private House	8
	Rental	6
	Living with friends, relatives	4
	Living with parents	2

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ISSN 1859-3666

A2: Classification results with 10 variables

		SEQ	Predicted Group Membership		Total
Original	Count		**1**	**2**	
		1	57	4	61
		2	9	52	61
	%	**1**	93.44	6.56	100
		2	14.75	85.25	100
		Ungrouped cases	0	100	100

A3: Group statistics of 5 most significant ratios

Variables	Std deviation	Coefficient	Scaled vector	Ranking
Edu	1.1137	0.2454	0.2733	3
Job	1.9085	0.0754	0.1439	4
RevenI(mill)	192.4863	0.8148	156.8389	1
DependantNb	0.8239	-0.2413	-0.1988	5
Account	3.2711	0.4011	1.3121	2

A4: Individual discriminating power of 5 variables

	Wilks' Lambda	F	df1	df2	Sig.
Edu	0.9458	6.8751	1	120	0.0099
Job	0.9285	9.2396	1	120	0.0029
RevenI(mill)	0.5773	87.8620	1	120	0.0000
DependantNb	0.9425	7.3189	1	120	0.0078
Account	0.8576	19.9327	1	120	0.0000

A5: "Scaled vectors" of 5 variables

Variables	Std deviation	Coefficient	Scaled vector	Ranking
Edu	1.1137	0.2454	0.2733	3
Job	1.9085	0.0754	0.1439	4
RevenI(mill)	192.4863	0.8148	156.8389	1
DependantNb	0.8239	-0.2413	-0.1988	5
Account	3.2711	0.4011	1.3121	2

A6: Classification results

Original		SEQ	Predicted Group Membership		Total
	Count		1	2	
		1	59	2	61
		2	11	50	61
	%	1	96.72	3.28	100
		2	18.03	81.97	100

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A7 (1): Calculations of Standardized Scores for 10representatives of Group 1

No	Y	*Edu*	*Job*	*RevenI(mill)*	*DependantNb*	Account	Std Z
1	2	8	10	1,051	1	0	859
2	2	8	8	1,000	0	6	820
3	2	8	10	1,000	2	6	819
4	2	8	8	800	1	6	657
5	2	6	8	720	1	10	593
57	2	8	10	180	2	6	151
58	2	8.5	10	180	2	6	151
59	2	8	8	180	2	0	149
60	2	8.5	8	180	1	6	152
61	2	8	9	168	1	0	139
	Mean						**286**
	Standard Deviation						**167**

A7 (2): Calculations of Standardized Scores for 10 representatives of Group 2

No	Y	*Edu*	*Job*	*RevenI(mill)*	*DependantNb*	Account	Std Z
1	1	5	4	216	2	0	177
2	1	8	8	168	2	6	141
3	1	8.5	7	156	2	0	129
4	1	8	7	150	1	6	127
5	1	9	8	150	3	0	124
57	1	5	4	48	2	0	40
58	1	8.5	7	48	0	0	42
59	1	6	4	43	3	0	36
60	1	5	0	20	0	0	17
61	1	5	0	18	1	0	16
	Mean						**82**
	Standard Deviation						**30**

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Summary

Trong bối cảnh nhiều ngân hàng Việt Nam hướng tới tín dụng tiêu dùng và cho vay cá nhân, bài báo này nhằm mục tiêu đưa ra một mô hình chấm điểm tín dụng cho vay tiêu dùng có thể áp dụng cho các ngân hàng Việt Nam. Bài báo sử dụng phương pháp của hệ thống FICO có tính đến tình hình của Việt Nam. Bài báo cũng nhằm mục tiêu giúp cho người tiêu dùng tính được điểm tín dụng của mình một cách đơn giản.

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1. Personal Profile

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2. Major Research Directions

- Bank Risk and Regulation
- Corporate Governance
- Rating, Scoring and Probability of Default
- Behavioral Finance and Banking
- Macroeconomics

3. Publications

- Journal of Trade Science
- Journal of Economics and Development
- Journal of Governance and Regulation
- Journal of Credit Risk
- Journal of Economics and Development
- Industry and Trade Magazine