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Measurement of Credit Risk Portfolio of Bank by Method of Coefficient Variation Bound

Amjad Zarei
Department of Statistics, Islamic Azad University, Sanandaj Branch, Sanandaj, Iran

Abstract: Owing to scientific progress, Today's world is moving ahead a process which creates better living conditions. On the other hand, during the past decades, the prevailing trend in economic and investment field has been determined in a way that hinders individuals' move to welfare. The example of this situation is granting bank loans to clients that this work has always been a problem for financial managers since there is competition and worry over capital return. Furthermore, risk and credit risk is of paramount importance in financial system because of risk determination and control protects banks against bankruptcy.Therefore, one way to reduce credit risk is to grant loans to clients based on Markowitz Portfolio Theory which is an appropriate option. For reach this goal in this research different approaches including discriminant analysis, logistic regression, grading models based on logistic regression and Delphi approaches to credit measurement have been applied.In order to do this, the model is developed through presenting a characteristic combination of coefficient of variance, principles, theorems and definitions are presented. In this study prior to granting loans their credit risk was analyzed and determined within a short time frame. The results indicated that used models are efficient for detecting outliers. Due to the efficiency of used models, these are possible to define a new credit risk measurement system in banks in order to act as quality control factor.

Key words: Bound, loans, portfolio, efficiency, Value at Risk (VaR), credit risk

INTRODUCTION

Current economic conditions of most countries all over the world are not suitable regarding to low probability of creating jobs and government failure to increase income. On the other hand, these conditions leads to increased request for bank loans and since banks do not have sufficient financial sources to grant loans.

This process is an urgent necessity for the design of a model to guarantee capital return for these countries. Furthermore, it should be noted that banks suffer the most where major loans are granted, besides such approaches as discriminant analysis and logistical analysis are time consuming and not convenient for ever one. The suggested model in this research is devoid of such defects and therefore targets client satisfaction has ease of use and is very convenient.

Iranian banks have a high percentage of loans which are not based on scientific approaches. Moreover, Iranian banks are forced to support the financial needs of new established businesses that are not capable of managing their own affairs. As a consequence of the latters' bankruptcy, the issue of risk gets high importance for those banks.

The concept of 'credit risk' originates from the fact that the counterparty might not be able or willing to undertake the duties due to fiscal failures on behalf of the counterparty or events of an economic nature such as inflation. Also, war and natural disasters which might put the counterparty through fiscal problems resulting in payment failure; therefore, so called 'credit risk' is intended to reduce loan side effects among loan receivers. This is an objective instrument of managing banks' credit risk and objectively classifying the counterparties based on quantitative and qualitative data.

So, many statistical methods have been used to reducing credit risk in banks in published works. The scientific methods such as variance (Parkinson, 1980), discriminant analysis (Altman, 1968), logistic regression (Hosmer and Lemeshow, 2000), ranking models base on logistic regression (Long, 1997) and credit measuring models such as Delphi method variance (Keil *et al*., 2002) are extremely time-consuming and difficult to use and may not be applicable to all cases. Therefore, an approach to reducing bank risk in minimum time becomes a matter of overriding importance.

Although, the present study developed a new approach to reducing credit risk in banks, the researcher failed to collect sufficient data due to the issue of

confidentiality which can also be considered as political. Therefore, it can be suggested that future studies attempt to shed more light on portfolio management and reducing credit risk. Finally, it should be noted that the present study is a small step to reduced credit risk and a stepping stone for future research.

Therefore, by considering the fluctuations in the economy of Iran, the purpose of research is focused the efforts toward finding a new method of portfolio risk estimation and management. The said method is called coefficient of variation bound which have many advantages.

This research was developed in the performance of the credit risk reduction approach that will be studied by the example of Iran's commercial banks. Thus, the researcher offers a quantitative credit risk assessment and management approach. The results of the research could be used as the basis to expand the scope of existing research and applications.

MATERIALS AND METHODS

The researcher has attempted to develop such an efficient model for reducing bank risk in minimum time to be applied by banks as far as prompt financial decision making is concerned. Accordingly, the researcher has developed a new scientific model for reducing bank risk entitled" Measurement of Credit Risk Portfolio of the Bank in Method of Coefficient Variation Bound". Using coefficient of variation and creation of abound, this model attempts to manage bank risk, bank capital capability and individual loan analysis in loan portfolio.

In other words, research methodology of study includes a survey of previous attempts concerning reducing bank credit risk such as DEA (Data Envelopment Analyses), LP (Linear Programming) and developing a new scientific method using coefficient of variation. The lingo software has been used for run the mention models (Akbari, 2007).

The Eqtesade Novin bank as an Iranian private bank was selected as the statistical population of the present study. In this regard, randomly selected 300 samples of (using Cochran Formula) three bank loans granted by this bank (Eqtesade Novin) within a 6 months period in 2011.

Practical and scientific significance: The method of bound and coefficient of variation and its application to the present research is new and different compared to other approaches. In addition to being simple, this new method enjoys ease of access and has no complications as far as application and computability ease are concerned.

From a historical point of view, problems related to portfolio management are the true reasons for bankruptcy or loss of banks and other financial institutions. Therefore, the availability of a proper system of granting loans and investment prospects assessment aiming at trust building and reduced credit risk for banks will be high contribution (AhmEd, 2009).

Coefficient of variation bound as criterion for risk concentration in portfolio loans proves applicable to Iranian banking system, specially private banks that are not supported by the government because no definite economic condition prevail Iran: the market is subject to sharp economic fluctuations and therefore, there is a necessity for such approach as coefficient of variation bound as criterion for risk concentration in portfolio loans (Ahmed, 2009). In other words, we have.

Accordingly l_i is equal toapplicants and the loan/granted to applicant n. Assume that a bank has and the simplest model considered for non-payment by the customers is payment and non-payment probability of loans that is a customer either repays the whole amount or simply refuses to repay it. Assume that we have (Mahmoodvand, 2008):

- n applicants
- l_i loan amount granted to applicants l_i
- Bi is a variable with parameter P_i (Indicative of the probability of non-payment of loan by the customer i and n)
- $L_i = Bl_i$ random variable of loan loss of applicant i
- $L_i = Bl_i$ and $p_i = p$ are independent variables
- $L = \sum L_i$ random variable of all loss from non-pay in loans secondly variable $L = \sum L_i$ has binomial distribution

$$E(L) = P\sum l$$

$$V(L) = P(1\text{-}P)\sum l^2$$

Thirty, for case limit when $n \to \infty$ (central limit theorem) L has normal distribution:

$$L \sim N\left(P\sum l, \sqrt{P(1-P)}\sum l^2\right)$$

So, we have inlevel of confidences:

$$P(L \le VaR) = 1-\alpha \Rightarrow P(Z \le \frac{VaR - E(L)}{\sqrt{V(L)}}) =$$

$$1-\alpha \Rightarrow \frac{VaR - E(L)}{\sqrt{V(L)}} = Z_\alpha \Rightarrow VaR = E(L) + Z_\alpha\sqrt{V(L)}$$

And this means that bank capital should at least $E(L)+Z_\alpha\sqrt{V(L)}$. In the other words, VaR is amount to we $E(L)+Z_\alpha\sqrt{V(L)}$ and if CLis indicative of minimum necessary capital, then have:

$$CL \geq VaR \Rightarrow CL \geq E(L)+Z_\alpha\sqrt{V(L)}$$
$$\Rightarrow CL \geq P\sum l+Z_\alpha\sqrt{P(1-P)}\sum l^2$$
$$CL \geq P\sum L(1+Z_\alpha CV)$$

- Problem 1; if show $CL \geq VaR$
- Problem 2; if $CL \geq P\sum L(1+Z_\alpha CV)$ we have

$$\left(\left(\frac{CL-P\sum l}{Z_\alpha\sqrt{P(1-P)}\sum l}\right)^2-\frac{1}{n}\right)\frac{n^2}{n-1}\geq CV^2$$

Theorem 1; suppose that $l_1, ..., l_n$ are payable loans to a applicant with coefficient variable and $\sum l_i = F$ and for i = 1, 2, ..., n relation $l_i \leq F/m$ is confirmed. We have:

$$CV \leq \sqrt{\frac{n(n-m)}{m(n-1)}}$$

In above relation when in sample from l_i are equal F/m and rest are equal zero, amount top border is creating and desired that you account the top border from above relation. Theorem 2; suppose CV is sample coefficient variable for observation $l_1, ..., l_n$.

$$(or\ X_1, ..., X_n),\ CV \leq \gamma$$

$\gamma < \sqrt{n}$ when all of observation are fixed we have show:

$$l < \bar{l}\sqrt{(n-1)\gamma^2+n},\ i=1,2,...,n$$

Or:

$$X < \bar{X}\sqrt{(n-1)\gamma^2+n}$$

This theorem is about proportion of one by one paid loan). Problem 3; when $\alpha_i^2 = l_i/\Sigma l^2$ and $0 \leq \alpha_i \leq 1$, α_i^2 is effect of loan it on concentration amount so amount of effect of one by one of loans is feasible. Show:

$$CV^2 = \sum\left(\frac{n^2\alpha_i^2-1}{n-1}\right)$$

Example; money loaned without interest, unilateral contract and bailment of capital offered by bank by Eqtesade Novin are as follow (Table 1).

Consider 0.12, 0.01 and 0.03 as the probability of non-payment for unilateral contract, bailment of capital and money loaned without interest, respectively. Bank funds regarding unilateral contract, bailment of capital and money loaned without interest are 80, 1 and 2, respectively.

Table 1: Loans without interest by Eqtesade Novin Bank

Row	Bailment of capital	Unilateral contract	Money loaned without interest
1	20	0.8	1.2
2	37	1.4	0.9
3	5	0.8	0.7
4	48	0.4	3.2
5	43	1.2	2.2
6	8	0.7	0.6
7	15	1.3	1.9
8	2	-	1.2
9	9	-	0.5
10	85	-	-

Table 2: Loans without interest by Eqtesade Novin Bank

Row	Bailment of capital A	Unilateral contract B	Money loaned without interest C
1	20.000	0.800	1.200
2	37.000	1.400	0.900
3	5.000	0.800	0.700
4	48.000	0.400	3.200
5	43.000	1.200	2.200
6	8.000	0.700	0.600
7	15.000	1.300	1.900
8	2.000	-	1.200
9	9.000	-	0.500
10	85.000	-	-
Σl	228.800	6.600	13.400
Σl^2	11265.040	7.020	26.480
Return l	22.880	0.943	1.490
Risk s	25.880	0.360	0.900
P(hypotheses)	0.120	0.010	0.030
$E(L) = P\Sigma l$	27.456	0.066	0.402
$V(L) = P(l-p)\Sigma l^2$	1189.590	0.069	0.771
$\sqrt{V(L)}$	34.490	0.260	0.880

- Calculate the added value regarding loan portfolio and interpret the results
- Measure risk concentration using coefficient of variation per each loan and interpret the results
- Calculate the coefficient of variation regarding loan loss and interpret the results
- Measure capital capability
- Perform loan analysis on a case by case basis (Table 2)

Introduction solution

Solution A: Refer to:

$$CV = \frac{\sqrt{V(L)}}{E(L)}$$

$cv = s/\bar{l}$ and $L = \sum L_i$, $L_i = pL_i$, l. In which n, loan applicants, loan amount, loan loss incurred by the customer, total

Table 3: Added value (Eqtesade Novin Bank)

Loan types case	Bailment of a capital A	Unilateral contract B	Money loaned without interest C
Return:1	22.80	0.943	1.49
Risk: s	25.88	0.360	0.90
VA = 1-s	3.00	0.583	0.59

loss due to non-repayment, coefficient of variation and coefficient of variation of loan loss, respectively (Table 3).

RESULTS AND DISCUSSION

Analysis: Since, VA is common regarding bailment of a capital, conditions of a bailment of capital is preferred (VA sign is not considered as significant in analysis).

Solution B: $CV_A = 25.88/22.88 = 1.13$, $CV_B = 0.36/0.943 = 0.38$, $Cv_c = 0.90/1.49 = 0.60$. Coefficient of variation is more significant than other factors in bailment of a capital and this shows that dispersion regarding bailment of a capital is significant, too but loan risk and loss is at a low level. However, risk concentration is rising.

As observed in bailment of a capital column, 85 is considered fragmentary data because it is higher than other data and may have affected the analysis. In order to survey this, we use median instead of mean: 2, 4.3, 5, 8, 9, 15, 20, 37, 43, 85. In which the median is 12. Then, we have:

$$CV_A = 25.88/12 = 2.16$$

As a result, the data cannot be interpreted differently because even now coefficient of variation regarding bailment of a capital is more significant than other factors.

Solution C: $CV_A = 34.49/27.456 = 1.26$, $CV_B = 0.26/0.066 = 3.94$, $CV_C = 0.88/0.402 = 2.18$. Coefficient of variation is less significant in bailment of capital; therefore, the risk involved is less significant, too.

Solution D measuring capital capability (VAR) note:

$$CL \geq VaR \Rightarrow CL \geq P\sum l + Z_{\alpha}\sqrt{P(1-P)\sum l^2}$$

VaR is value at risk, CL is intended to mean capital limit (in this dissertation, we can claim that VaR refers to minimum capital required by the bank for estimating probable) and P refers to portfolio amount $Z_{0.05} = 1.96$ loss due to non-repayment (probability of non-repayment). For example, the probability of non-repayment of bailment of a capital, unilateral contract and money loaned without interest is 0.12, 0.01, 0.03. And bank funds for paying the aforementioned loans will be 80, 1 and 2, respectively (Table 4).

Step 1: Calculating the least capital:

$$CL_A \geq 0.12(228.8) + 1.96\sqrt{0.12(1-0.12)(11265.04)}$$
$$= 95.06,\ CL_B \geq 0.01(6.6) + 1.96\sqrt{0.01(1-0.01)(7.02)}$$
$$= 0.58,\ CL_C \geq 0.03(13.4) + 1.96\sqrt{0.03(1-0.03)(26.48)}$$
$$= 2.12$$

Step 2: Therefore, except for unilateral contract, bank does not have capital capability to assess probable loss regarding bailment of capital and money loaned without interest.

Step 3: Results: So bankroll to meet potential losses in unilateral contract loan is enough but not in money loaned without interest or bailment of a capital. So enough bankroll to fulfill the potential losses is not sufficient in money loaned without interest but it's sufficient in mortgage loans.

Solution E

Case 1: bailment of a contract:

$$\left(\left(\frac{(95.06 - 0.12(228.8))}{1.96\sqrt{0.12(1-0.12)(228.8)}}\right)^2 - \frac{1}{10}\right) \quad (A)$$
$$\frac{10^2}{10-1} \geq CV^2 \Rightarrow 1.28 \geq CV^2$$

$$l_i < \bar{l}\sqrt{(n-1)CV^2 + n} \Rightarrow l_i < 22.88 \quad (B)$$
$$\sqrt{(10-1)1.28 + 10} \Rightarrow l_i < 106.14$$

Analysis: All loan amounts are less than 106.14 as far as bailment of a capital is concerned. In other words, 20, 37, 5, 48, 43, 8, 15, 2, 9, 85<106.14. Therefore, all loan amounts are acceptable but since bailment of a capital of 85, 43, 37 is higher than mean 22.88 that is 37, 48, 43, 85>22.88 and also, according to problem 3, bailment of a contract of 85, 43 and 37 causes a reduction in risk concentration, it is advisable not to offer such loans.

Case 2: unilateral contract:

$$\left(\left(\frac{(0.58 - 0.01(6.6))}{1.96\sqrt{0.01(1-0.01)(6.6)}}\right)^2 - \frac{1}{7}\right) \quad (A)$$
$$\frac{7^2}{7-1} \geq CV^2 \Rightarrow 0.13 \geq CV^2$$

$$l_i < \bar{l}\sqrt{(n-1)CV^2 + n} \Rightarrow l_i < 0.943 \quad (B)$$
$$\sqrt{(7-1)0.13 - 7} \Rightarrow l_i < 2.63$$

Table 4: Least capital by Eqtesade Novin Bank

Loan types bank funds	Bailment of a capital A	Unilateral contract B	Money loaned without interest C
Principal capital	80.0	1.00	2.00
least capital	95.6	0.58	2.12
Interpretation	Since the total fund is less than the minimum fund, then it is not sufficient enough to assess probable loss	Since total fund is more than minimum fund, then it is sufficient enough to assess probable loss	Since the total fund is less than the minimum fund, then it is not sufficient enough to assess probable loss

Analysis: All loan amounts in unilateral contract is <2.63 that is 0.8, 1.4, 0.8, 0.4, 1.2, 0.7, 1.3<2.63. Therefore, all loan amounts are acceptable but since bailment of a capital of 1.4, 1.3 and 1.2 is higher than mean 0.943 that is? and according to problem 3, unilateral loans of 1.4, 1.3 and 1.2 cause a reduction in risk concentration, it is advisable not to offer such loans.

Case 3; money loaned without interest:

$$\left(\left(\frac{\left(2.12-0.03(13.48)\right)}{1.96\sqrt{0.03(1-0.03)(13.48)}}\right)^2-\frac{1}{9}\right) \quad (A)$$

$$\frac{9^2}{9-1}\geq CV^2 \Rightarrow 0.30\geq CV^2$$

$$l_i<\bar{l}\sqrt{(n-1)CV^2+n} \Rightarrow l_i<1.49 \quad (B)$$

$$\sqrt{(9-1)0.30+9} \Rightarrow l_i<5$$

Analysis: All loan amounts in money loaned without interest are <5 that is 1.2, 0.9, 1.7, 3.2, 2.2, 0.6, 1.9, 1.2, 0.5<5. Therefore, all loan amounts are acceptable and since money loaned without interest of 3.2, 2.2, 1.9 and 1.7 is higher than mean 1.49 that is? and according to problem 3, money loaned without interest of 3.2, 2.2, 1.9 and 1.7, causes a reduction in risk concentration, it is advisable not to offer such loans.

In loan portfolio, all 3 offered loans should be <106.14, 2.63 and 5, respectively. Loans more than mean loan rates will cause an increase in risk; therefore, it is advisable not to offer such loans.

CONCLUSION

The present study developed a new approach to reducing credit risk in banks. The Eqtesade Novin bank as an Iranian private bank was selected as the statistical population of the present study. According to the findings of the research the following have been concluded:

- At present the loan extension methods or strategy available at Iranian banks have no scientific ground, hence they there is a need for fundamental changes
- The presented new method is based on coefficient of variation bound and has some advantages such as ease of use and timely control of credit risk
- Establishment of control department in each bank toward better management of portfolio risks in general
- Developing procedures based on scientific approaches toward both preventing and durecing the credit risk
- One feature of such a model is its applicability to comparing different loans in unequal quantities which is shown by the 3rd example

SUGGESTIONS

Based on the analysis of data in the present study, the researcher, due to his familiarity with statistical quality control, came up with a surprising result: Although scientific risk control is probable, banks control risk with the help of bailers and through circulars using an experimental method and risk control is not efficient, therefore, risk control should be undertaken by a statistical quality control expert, Pareto's principle should be used to overcome any inefficiency.

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