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Applying Discriminant Model to Manage Credit Risk for Consumer Loans in Vietnamese Commercial Bank

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Abstract. This study estimates a two-group discriminant function to determine the expected financial health of the consumer credit customers' of a bank of Vietnam by using five demographic, socio-economic, and loan characteristics of the sample borrowers. The estimated function is significant at one per cent level of significance and the model estimates financial health/group membership with average seventy-three per cent accuracy. Like developed countries, it is expected that use of the estimated discriminant function in the consumer credit decision making will decrease bad debts, will help to set risk based credit pricing for the clients and will make the credit granting faster and more accurate.

Keywords: consumer credit; financial distress; prediction; demographic and socio-economic characteristics; two-group discriminant analysis.

Применение дискриминационной модели в управлении риском потребительских кредитов в коммерческом банке Вьетнама

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В данной работе с помощью бинарной дискриминационной функции проведена оценка ожидаемого финансового «здоровья» пользователей потребительских кредитов, предоставляемых банком Вьетнама, используя пять демографических, социально-экономических видов займов характеристик пробы заемщиков. Оцениваемая дискриминационная функция оказалась достоверной при 1%-ном уровне значимости и применении модели оценки финансового «здоровья» потребителей выбранной группы потребителей, что дало результат с 73%-ной достоверностью. В развитых странах предполагается, что применение оценки с помощью дискриминационной функции при принятии решения в области потребительского кредита будет способствовать снижению числа плохих долгов, а также даст возможность устанавливать оценку платежеспособности с учетом риска. Это поможет ускорить оформление кредита и поднять уровень его обеспеченности.

Ключевые слова: потребительский кредит; финансовое неблагополучие; демографические и социально-экономические характеристики; бинарный дискриминационный анализ.

1. INTRODUCTION

The idea of consumer credit is extensive. In general, consumer credit is the term stands for the express loan facilities to the common people that have to repay with interest by equal monthly installment and the credit is not used for any commercial purpose. The need of consumer credit today is at its highest, but at the same time the default rates have risen and from the banks' perspective the riskiness of these loans is usually higher than granted loans they analyzed defaulted. For the lending institution such a default rate affects to its financial performance significantly. So, it is substantially better to use discriminant analysis to determine the expected position or a score for the borrower to make the credit grant decision. In other words, a quantitative effort is made to forecast the expected position of the consumer credit applicant via the discriminant analysis. In the current paper, we use the discriminant analysis to develop predictive models allowing distinguishing between "good" and "bad" borrowers. The data have been collected from commercial Vietnamese banks over a 3-year period, from 2014 to 2016.

The discriminant analysis is look like the regression analysis in terms of the number of dependent variables (one for both), the number of independent variables (multiple for both) and the nature of independent variables (metric for both). But, the discriminant analysis and the regression analysis are different in terms of the nature of dependent variables. In the regression analysis, the dependent variable is

a metric variable whereas in the discriminant analysis, the dependent variable is a categorical/binary variable. Besides, the nature of the dependent variable in the binary logit model and the two-group discriminant analysis is the same. The linear discriminant analysis model involves linear combinations of the equation 1 form:

$$Z = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \dots + \beta_k X_k. \quad (1)$$

In the model, Z = discriminant score, α = constant, β 's = discriminant coefficient or weight, X 's = predictor or independent variable. The coefficients of the independent variables are estimated such that the scores differ for the two groups substantially. This happens when the ratio- between-group sum of squares to within-group sum of squares is at maximum point. For any other combination, the ratio will be smaller. The **Figure 1** shows the pictorial presentation of the data collected on the two variables: X_1 and X_2 for the cases of the two-group G_1 and G_2 . The X_1 axis represents X_1 variable and the X_2 axis represents X_2 variable. The discriminant analysis tries to separate the two groups by drawing a line as under. If the data is collected on more than two variables, then it is not possible to draw a scatter diagram as under as we have fixed two axes in a graph. But regardless of the number of variables, the discriminant analysis can generate positive and negative Z scores for the cases of the groups and possible to draw a diagram as a lower part of the **Figure 1**. The lower part represents the group membership by

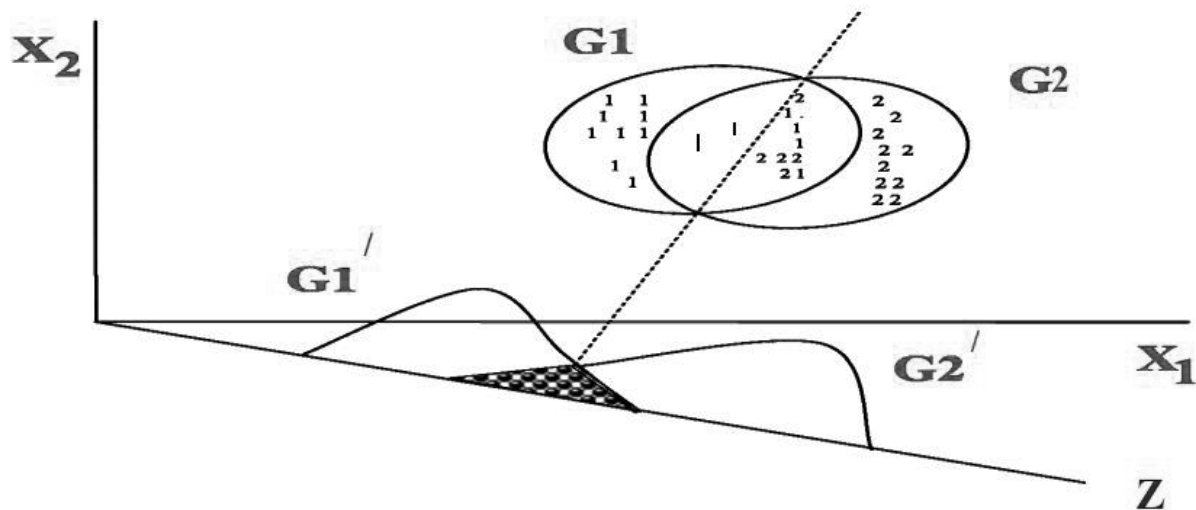


Figure 1. Discriminant Analysis

using the estimated discriminant scores (Z) of the groups cases. The shaded proportion represents the misclassification of the group membership. The smaller the shaded proportion, the bigger the estimation accuracy is assumed (Malhotra & Das, 2011; Boyd, Westfall, & Stasch, 2005)

The objectives are divided into two-broad objective and specific objectives. The broad objective of the study is to determine the consumer credit customers' insolvency by using demographic & socio-economic characteristics and two-group discriminant analysis. In consistent with the broad objective, the specific objectives are as follows: (i) To develop discriminant function or linear combinations of the predictor, or independent variables, which will best discriminate between the categories of the criterion or dependent variable. (ii) To examine whether significant differences exist among the groups 'in term of the predictor variables'. (ii) To determine which predictor variables contribute to most of the inter group differences. (iii) To classify cases to one of the groups based on the values of the predictor variables. (iv) To evaluate the accuracy of the classification. The first section of this research report is about introduction to the study which comprises prologue, objectives and methodology of the study. The second section contains literature review and the variables selection for the study. Empirical study in Vietnam's commercial banks, findings and their analysis are in the third section of the report.

2. LITERATURE REVIEW

2.1. Statistical methods for credit risk prediction

In the past, many researchers have developed a variety of traditional statistical methods for corporate credit risk prediction, with utilization of Linear discriminant analysis (LDA) and Logistic regression analysis (LRA) being the two most commonly used statistical methods in building corporate credit risk prediction models. Possibly the earliest use of applying LDA to corporate credit risk prediction is the work by Durand (1941). However, Karels and Prakash (1987) and Reichert et al. (1983) pointed that the application of LDA has often been challenged owing to its assumption of the categorical nature of the corporate credit data and the fact that the covariance matrices of the credit risk and non-risk classes are unlikely to be equal. In addition to the LDA approach, LRA is another commonly used alternative to conduct corporate credit risk prediction tasks. Thomas (2000) and West (2000) indicated that both LDA and LRA are intended for the case when the underlying relationship between variables are linear and hence are reported to be lacking in sufficient prediction accuracy. Besides above two statistical methods, Friedman (1991) reported that Multivariate adaptive regression splines (MARS) is another commonly corporate credit risk prediction method. However, the problem with applying these statistical methods to corporate credit risk prediction is that some assumptions, such

the multivariate normality assumptions for independent variables, are frequently violated in reality, which makes these methods theoretically invalid for finite samples.

Although these methods are relatively simple and explainable, the ability to discriminate credit non-risk customers from credit risk ones is still an argumentative problem. In recent years, many studies have demonstrated that Artificial intelligence (AI) methods, such as Artificial neural network (ANN) (West, 2000), Decision tree (DT) (Jiang, 2009), case based reasoning (CBR) (Shin & Han, 2001) and Support vector machine (SVM) (Schebesch & Stecking, 2005) can be used as alternative methods for corporate credit risk prediction. In contrast with statistical methods, AI methods do not assume certain data distributions. These methods automatically extract knowledge from training samples. According to previous studies, AI methods are superior to statistical methods in dealing with corporate credit risk prediction problems, especially for non-linear pattern classification (Huang et al., 2004; West, 2000).

2.2. Discriminant Analysis for consumer credit

Wiginton (1980) conducted a discriminant analysis to model the consumer credit behavior by using demographic and economic variables. The demographic variables used are: number of dependents, living status, moved during last year, business use of vehicle and pleasure use of vehicle. The economic variables include industry class of employment, class of occupation and years in present employment. The right prediction power of the model estimated by the researcher is not encouraging and predicting group membership by using logit model provided better forecasting accuracy. It is concluded that years in present employment, living status and occupation type are significantly related to the credit risk rating. Grablowsky (1975) conducted a two-group stepwise discriminant analysis in order to model risk in the consumer credit by using behavioral, financial, and demographic variables. The behavioral data is collected from the two hundred borrowers through a questionnaire of summated ratings scale and the financial and demographic data are collected from the loan application forms of the same

two hundred borrowers. The researcher has started analysis with thirty six variables and after a comprehensive sensitivity analysis, found that thirteen variables are enough to model the consumer credit risk. Although the both set of data- analysis sample and holdout sample violated the equal variance-covariance assumptions, the estimated model classified the validation sample 94 per cent correctly. Awh & Waters (1974) conducted a study to determine the bank's active and inactive credit card holders by using two types of variables-quantitative (economic and demographic) and attitudinal. The quantitative variables used are: (a) income, (b) age, (c) education, and (d) socio-economic standing. The socio-economic index is based on the respondents' particular position suggested by Reiss (1961). The attitudinal variables used are: (a) use or non-use of other credit cards, (b) attitude toward credit, and (c) attitude toward bank charge-cards. The data for the quantitative and attitudinal variables on the same respondent is collected from the loan application forms and by the questionnaires respectively. The discriminant function estimated by them is significant at 0.01 level and forecasted the group membership with 78 per cent accuracy. Hand & Henley (1997) reviewed available credit scoring techniques in their article titled – "Statistical Classification Methods in Consumer Credit Scoring: A Review." In addition to the judgmental method, the available quantitative methods are logistic regression, mathematical programming, discriminant analysis, regression, recursive partitioning, expert systems, neural networks, smoothing nonparametric methods, and time varying models. They have concluded that there is no best method. What is the best method depends on the structure and characteristics of the data. For a data set, one method may be better than the other method but for another data set, the other method may be better.

In addition, Davis, Edelman & Gammerman (1992) conducted a comparative study of various methods and concluded that all the methods are performed at the same accuracy level but the neural network algorithms take much longer time to train. According to Hand & Henley (1997), characteristics typical to differentiate the problematic and regular customer are:

time at present address, home status, post code, telephone, applicant's annual income, credit card, types of bank account, age, country code judgment, types of occupation, purpose of loan, marital status, time with bank and time with employers, etc. The partial list of characteristics those may be useful to determine the group membership given by Capon (1982) includes the variables-telephone at home, own/rent living, age, time at home address, industry in which employed, time with employer, time with previous employer, type of employment, number of dependents, types of credit reference, income, savings and loan references, trade union membership, age difference between man and wife, telephone at work, length of product being purchased, age of automobiles, geographical location, debt to income ratio, monthly installment etc. Dinh & Kleimeier (2007) conducted a study for the Vietnam's retail banking market by using logistic regression analysis method. The variables they have used are age, education, occupation, total time in employment, time in current job, residential status, number of dependents, applicants annual income, family income, short-term performance history with the bank, long-term performance history with the bank, total outstanding loan amount, other services used, cash in hand and at bank, etc. They have argued that by using quantitative credit scoring, the default rate can be minimized from 3.3 per cent to 2.0 per cent. They also argued that by quantifying the credit risk, it is possible to set up risk-based pricing in the retail banking market. Consequently, the bank can become more efficient and competitive in the market. The most important predictors they found are time with bank, followed by gender, number of loans, and loan duration. Based on the above literature review, experience of the researcher and availability of the data, thirteen demographic and socio-economic variables are selected for this study. The variables are the loan amount, number of dependents, years of experiences at present job, salary per month, living status, savings per month, cash in hand and at bank, Net worth, ACT, N-EMI, EMI, interest rate (%), and Guar. The data is collected on the variables from the application forms of the consumer credit customers by filling up the pre-designed questionnaire.

3. RESEARCH METHODOLOGY

3.1. Research design

To be considered as one of the most broadly techniques used to discriminate between two groups (Abdou & Pointon, 2011), discriminant analysis has long been used by researchers and bank's managers for building credit scoring models to distinguish between customers as good credit and bad credit (Abdou & Pointon, 2009; Sarlija et al, 2004; Caouette et al, 1998; Hand et al, 1998; Hand & Henley, 1997 and Desai et al, 1996). Therefore, in this article, discriminant model will also be used to distinguish between two loan borrower classification groups: repayment and non-repayment, in which good borrower is coded as 1 and bad borrower is coded as 0. This use of two groups of customers which are either good or bad ones is also considered as one approach for classification purposes in credit scoring models by many researchers such as Kim & Sohn, 2004; Lee et al, 2002; Banasik et al, 2001; Boyes et al, 1989 and Orgler, 1971. These two possible states are defined by a number of factors which simultaneously influence on borrower's ability to pay and willingness to pay. In case of this study, information related to age, salary, years at present career, loan amount and number of independents will be used to calculate discriminant score Z for a given customer as follows:

$$Z_i = \beta_0 + \beta_1 * X_1 + \beta_2 * X_2 + \beta_3 * X_3 + \beta_4 * X_4 + \beta_5 * X_5 + \varepsilon \quad (2)$$

Where:

Z is the discriminant score that maximizes the distinction between the two groups:

β_0 : constant.

β_{1-5} : slopes of independent variables.

X1: Age

X2: Dependents

X3: YAPJ

X4: Salary

X5: Loan amount

ε : random error.

As can be seen from the model, there are two types of variables in this model, which are dependent and independent variables. The only dependent variable is status of borrower that is a categorical variable. If a borrower's position is default then he is denoted by 0 and if the bor-

rower's position is regular, then he is denoted by 1. By contrast, there are two types of the predictor variables are used in this study. Particularly, some variables are related with the loan and the others are related with the demographic and socio-economic conditions of the borrower. The variables related with the demographic and socio-economic conditions of the borrower are as follows. Age: How old borrower is; Dependents: Dependents mean the number of persons who are dependent on the borrower; YAPJ stands for years at present job; Salary: how much money earned by the borrower per month. The independent variable related with the loan is loan amount which indicates how much money borrowed by the borrower.

Secondary data will be used in this study instead of primary data. To explain for this choice, advantages of using secondary data will be analyzed. Firstly, using secondary data, which already been available in commercial banks, might enables me to save time and money (Ghauri & Grnhaug, 2006). Moreover, Stewart and Kamins (1993) indicate when comparing between secondary data and own collected data, the quality of former is higher than latter. Finally, secondary data has also been used in many researches on credit scoring conducted by researchers not only in Vietnam (Duong, Tran & Ho, 2015) but also in other countries like Wiginton (1980); Elena Bartolozzi, Matthew Cornford, Leticia García-Ergüín, Cristina Pascual Deocón, Oscar Iván Vasquez & Fransico Javier Plaza (2008) and Hörkkö (2010). As a result of that, secondary data collected from commercial banks in Vietnam will be used.

Besides, related to sample size, it is said that the larger the sample size, the better the scoring model's accuracy. However, it is also worth noting that "a sample size of at least twenty observations in the smallest group is usually adequate to ensure robustness of any inferential tests that may be made" (Hintze, 1998). Therefore, in case of this model in which the number of independent variables is five, there should be at least 100 cases in smallest group to produce right discriminant function.

According to the World Bank, the proportion of non-performing loans to total gross loans in Vietnam is about 2.94% or in other words the number of non-default borrowers is relatively

higher than their counterparts, leading to the number of good and bad borrowers taken from banks in this study is not the same. Therefore, like the way other researchers such as Lee et al (2002); Desai et al (1996); Boritz & Kennedy (1995) and Dutta et al (1994) did, this study also choose the proportion of good borrowers to bad ones used was seven to three. Particularly, in case data of 500 customers will be used in this study, the number of good borrowers will be 350 while their counterpart ones was 150. Moreover, information on 500 customers then will randomly be divided into two different groups named analysis sample and hold out sample. The former including 400 customers will be used to estimate discriminant function while the later including 100 customers will be used to check the validity of the model.

As data used in this study is numerical data, of which value can be measured numerically (Saunders et al, 2007), quantitative approach was applied. Particularly, quantitative approach was used to measure differences in means of independent variables between two groups. Moreover, quantitative analysis was also used to look for connections and spot relationships between independent variables.

3.2. Statistical analysis and checking assumptions

Before running discriminant analysis, it is important to describe characteristics of all variables used in this study and check assumptions to make sure that study's findings are accurate. In this study, data was processed by SPSS 21.

Firstly, as data in this study are continuous variables, descriptive was used to explore basic statistics such as mean, maximum, minimum, standard deviation of predictors in each group. Besides, independent sample T test SPSS was also used in this study to compare mean score on predictors between non defaulted and already defaulted group (Pallant, 2013).

Secondly, it is required that data used in discriminant analysis must be independent and normally distributed (Khemakhem and Boujelbene, 2015); therefore, like other researches this study also accesses normality of data's distribution by the Kolmogorov-Smirnov test on SPSS.

Thirdly, not only normal distribution, but outliers and multicollinearity were also tested

to make sure results of further tests are accurate (Field, 2009; Pallant, 2013). It is clear that the presence of an outlier, which is defined as cases of which values are quite higher or lower than majority of other cases' ones (Pallant, 2013), might make researchers miss important information and receive confusing results; therefore, it is essential to recognize outlier (Dielman, 2001). Tails of distribution presented in graph named histogram was used to find out there is potential outliers in this study or not. There are some observations are out at the outlier labeling rule, which after that will be eliminated. Besides, the existence of multicollinearity or explanatory variables are correlated might lead to estimates of parameter values are not reliable, and it is difficult for researchers to access the contributions of each independent variable to overall R^2 (Gujarati, 1999). Therefore, this study used results obtained from correlation matrix, which presents not only correlation between dependent variable and predictors, but also between independent variables to test for multicollinearity. Particularly, Pearson produced moment correlation coefficient will be used. The highest absolute value of correlation coefficient between each of independent variable should be less than 0.7 to ensure that multicollinearity does not happen in this study.

After checking and correcting problems related to data, the next step is to apply discriminant analysis to the analysis sample. However, it is

worth noting that there are two common methods for discriminant analyses, which are direct method and stepwise discriminant analysis. In this study, which is based on the previous research and theoretical model, the direct method will be used.

4. RESULTS

As can be seen from the table named group statistics, group means and standard deviations are calculated for each variable of the default and the non-default groups, which after that contributes to see whether the variables can differentiate between default customers and regular customers. It is true that, except for salary clear differences are witnessed in group means for the groups for the variables age, years at present job, number of dependents and loan amount. Particularly, average age for credit-worthy borrowers, which is about 36 years old, is relatively higher than average age for the bad ones which is only a little above 30 years old. This result supports for conclusion of Vasanthi and Raja (2006) who said that the probability of default is higher with a younger borrower. The same pattern is also witnessed in term of number of dependents. This might be explained by the fact that the more people borrowers have to support financially, the less money they have to pay loan or borrowers are likely not to pay loan in time. Moreover, there is big difference in years at present job between borrowers who are con-

Table 1. Group Statistics

	Ability to pay loan	N	Mean	Std. Deviation	Std. Error Mean
Age	Not good	120	30.719	3.9987	.3161
	Good	280	36.772	5.5364	.2922
Salary	Not good	120	13.0419	4.19951	.33200
	Good	280	14.0351	4.92672	.26410
Years at present job	Not good	120	5.38	2.454	.194
	Good	280	10.26	3.679	.194
Number of independents	Not good	120	2.03	.812	.064
	Good	280	1.53	.854	.045
Loan amount	Not good	120	398677156.250	165445876.1431	13079644.9524
	Good	280	469608695.652	261697678.4845	14089329.3907

Table 2. Tests of Normality

	Kolmogorov-Smirnova			Shapiro-Wilk		
	Statistic	Df	Sig.	Statistic	Df	Sig.
Age	.095	400	.000	.968	396	.000
Salary	.097	400	.000	.948	390	.000
YAPJ	.079	400	.000	.962	392	.000
Dependents	.317	400	.000	.833	397	.000
Loan amount	.088	400	.000	.910	385	.000

sidered as credit worthy and not. Table 1 shows that average value of years at present job of no defaulted borrowers is nearly twice already defaulted borrowers' ones. By contrast, the dissimilarity in monthly salary between good and bad borrowers is slight, which income among the defaulters is only one million VND lesser than the non-defaulters. More importantly, this difference might contribute to explain why loan amount of non-defaulters is relatively higher than defaulters.

As mentioned above, data used in discriminant analysis should be normally distributed (Khemakhem and Boujelbene, 2015); therefore, K-S test was used to find out whether distribution of data used in study is normal or not.

The test statistic for the K-S test is presented in table 2 showing that the percentage of age $D(396) = 0.095$, $p = .000$, which was smaller than 0.05; therefore, the distribution is not normal (Pallant, 2013). The same pattern also was witnessed in salary, years at present job, number of dependents and loan amount. To correct this problem, according to Field (2009), transforming data is one of popular options. Therefore, in this study, all variables were transformed into log transformation, which is as the same as method used by Hörkkö (2010). More importantly, Reichert (1983), Hand et al (1996) and Uddin (2013) proved that discriminant analysis still get good result in case data used is not normally distributed. As a result of that, this problem in this study is not serious.

Besides, by looking at the tails of distribution presented in graph named histogram (Appendix 6), this study found that there are potential outliers because there are some observations are out at the outlier labelling rule. However, when considering information in descriptive table, the

difference between 5% trimmed mean (4.719) and mean (4.7161) values is extremely small; therefore, outlier problem in this study is not serious and might be solved by eliminating outliers.

According to Pallant (2013), multicollinearity happens when absolute value of correlation coefficient between each of independent variables is 0.7 or more. The correlations between variables used in this study (Table 3) showed the first largest bivariate correlation was listed for relationship between age and years at present job. Unfortunately, this pair-wise correlation was only 0.770, which was clearly higher than 0.7; therefore, multicollinearity does happen and age will be omitted from regression.

As the sig. (2-tailed) value for predictors are below the required cut-off of 0.05; there is statistically significant difference in salary, YAPJ, number of dependents and loan amount between the defaulters and non-defaulters.

Wilks' lambdas and the F ratios are estimated to test the equality of the group means. The value of the Wilks' lambda (λ) varies between 0 and 1. While the large value of λ indicates that group means are not different, small value of λ indicates that the group means are different or in other words the smaller the Wilks's lambda, the more important the independent variable to the discriminant function. Wilks's lambda is significant by the F test for all independent variables. The lower significant ratio for the corresponding F ratio means — the variable is very significant in the case of determining group membership. Therefore, based on results presented in Table 4, it is obvious that dependents and years at present job may best discriminate between the two groups of borrowers.

Table 3. Correlations

		Ability to pay loan	Age	Salary	Years at present job	Number of dependents	Loan amount
Ability to pay loan	Pearson Correlation	1	.480**	.098*	.560**	-.263**	.139**
	Sig. (2-tailed)		.000	.028	.000	.000	.002
	N	400	396	390	392	397	385
Age	Pearson Correlation	.480**	1	.106*	.770**	-.033	.063
	Sig. (2-tailed)	.000		.018	.000	.454	.161
	N	396	396	390	392	396	385
Salary	Pearson Correlation	.098*	.106*	1	.131**	.258**	.611**
	Sig. (2-tailed)	.028	.018		.003	.000	.000
	N	390	390	390	390	390	385
Years at present job	Pearson Correlation	.560**	.770**	.131**	1	-.193**	.016
	Sig. (2-tailed)	.000	.000	.003		.000	.715
	N	392	392	390	392	392	385
Number of dependents	Pearson Correlation	-.263**	-.033	.258**	-.193**	1	.223**
	Sig. (2-tailed)	.000	.454	.000	.000		.000
	N	397	396	390	392	397	385
Loan amount	Pearson Correlation	.139**	.063	.611**	.016	.223**	1
	Sig. (2-tailed)	.002	.161	.000	.715	.000	
	N	385	385	385	385	385	385

*Correlation is significant at the 0.05 level (2-tailed).

**Correlation is significant at the 0.01 level (2-tailed).

The group centroids are the averages of the Z values calculated by the estimated model, which can use to evaluate the expected position of the consumer credit customers (Uddin, 2013). As can be seen in table 10, the centroid of not good borrower is -1.380 and the centroid of the regular group is 0.671. Therefore, if the estimated Z value of a customer is negative, then the expected status of this customer is default because the centroid value is negative for default group and if the estimated value of a case is positive then the expected position of the case is good borrower as the centroid value is positive for the regular group.

The classification matrix of the original sample (Table 7) shows that 81.5 percent of the case are predicted by the model correctly. Since at the time of estimating classification matrix of the original cases, the sample for which the prediction is made included in the sample, the classification matrix may be biased. So, cross-validated classification matrix is made based on the activity that the case for which the prediction is being made will be kept out of the analysis and the model is estimated. Result presented in Table 7 shows that 81.5% of the cross validated grouped cases are classified correctly. The holdout sample is also used to check

Table 4. Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Salary	Equal variances assumed	1.058	.304	-2.207	506	.028	-.99318	.44992	-1.87712	-.10925
	Equal variances not assumed			-2.341	358.176	.020	-.99318	.42423	-1.82748	-.15888
YAPJ	Equal variances assumed	13.007	.000	-15.342	516	.000	-4.888	.319	-5.513	-4.262
	Equal variances not assumed			-17.793	440.828	.000	-4.888	.275	-5.427	-4.348
Number of dependents	Equal variances assumed	7.649	.006	6.220	521	.000	.497	.080	.340	.654
	Equal variances not assumed			6.344	318.735	.000	.497	.078	.343	.651
Loan amount	Equal variances assumed	16.188	.000	-3.148	503	.002	-70931539.4022	22531078.8278	-115198156.3286	-26664922.4757
	Equal variances not assumed			-3.690	457.412	.000	-70931539.4022	19224627.8185	-108711081.8770	-33151996.9274

Table 5. Tests of Equality of Group Means

	Wilks' Lambda	F	df1	df2	Sig.
Logloanamount	.995	2.543	1	385	.111
Logdependents	.884	64.010	1	385	.000
Logsalary	.997	1.612	1	385	.205
LogYAPJ	.595	331.959	1	385	.000

Table 6. Eigenvalues

Function	Eigenvalue	% of Variance	Cumulative %	Canonical Correlation
1	.980a	100.0	100.0	.704

a. First 1 canonical discriminant functions were used in the analysis

Table 7. Classification Results^{a,c}

Ability to pay			Predicted Group Membership		Total
			0	1	
Original	Count	Not good	92	21	113
		Good	51	225	276
		Ungrouped cases	0	11	11
	%	Not good	81.3	18.8	100.0
		Good	18.5	81.5	100.0
		Ungrouped cases	.0	100.0	100.0
Cross-validated ^b	Count	Not good	92	21	113
		Good	51	225	276
	%	Not good	81.3	18.8	100.0
		Good	18.5	81.5	100.0

a. 81.5% of original grouped cases correctly classified.

b. Cross validation is done only for those cases in the analysis. In cross validation, each case is classified by the functions derived from all cases other than that case.

c. 81.5% of cross-validated grouped cases correctly classified.

the validity of the model. After putting the values of the holdout sample on the estimated discriminant function, the Z values are computed for the cases. By using the Z values and centroids, group membership is predicted. The Table 8 shows that 72.3 percent of cases are correctly classified.

5. CONCLUSION

This study estimates a two-group discriminant analysis in order to determine the expected

status of the consumer credit customers of a bank in Vietnam. The estimated function is significant at 1 per cent level of significance and could forecast financial health with average 72.3 per cent accuracy. Thus, the study proposed that the demographic, socio-economic and loan related variables can be used to determine the expected group membership of the borrowers in Vietnam. Discriminant function estimated for an institution or bank

cannot be used for other bank or institution because the discriminant function coefficients will vary based on a bank/institution's data set. Hence banks/institutions should use own data base to estimate its own discriminant function to use. By using the estimated function, the consumer credit disbursement decision can be faster, more accurate and cost saving. Moreover, risk based pricing can be adapted in the credit management.

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Lean Construction and BIM: Complementing Each Other for Better Project Management

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Abstract. Recently lean construction concept and building information modeling (BIM) have become one of most mainstream tools for solving many project management problems in construction. Thus, the purpose of this article is to investigate opportunities of increasing project management efficiency in construction by integrated use of lean construction principles and building information modeling. Results of contemporary research on lean construction and BIM were inspected. Analysis and synthesis methods were used to achieve the goals of this research. Knowledge of project management methodology was combined and matched to the known tools of lean construction and BIM to generate ways in which the latter can contribute to more efficient project management in the era of knowledge-based economy and rise of information technologies. The research has shown that the vast majority of lean construction principles can be practically realized with the use of BIM (eight of them – fully, four – partly, another four – none). The authors systematized the benefits of simultaneous application of Lean and BIM in existing knowledge fields of project management (project quality, risks, cost, time, scope, human resources, communications, procurement and stakeholders management). Lastly, the consequent link from lean principles to BIM to project management objectives and to overall business success were shown. The presented results correlate with ideas mentioned in most research on the topic. However, it is seen that more emphasis in the article unlike other research were put on the specific opportunities of lean and BIM application for project management. Thus, the results can be useful for further research of academics (especially in Russia, where this topic isn't covered enough) as well as for project managers and other specialist in construction industry.

Keywords: BIM, lean construction principles; project management; construction; integrated use; benefits.

Бережливое строительство и BIM-модель: дополняя друг друга для более эффективного управления проектами

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Аннотация. В последнее время концепции бережливого строительства и информационного моделирования сооружений (BIM) стали основными инструментами решения ряда управленческих вопросов в строительстве. В статье предпринята попытка оценки возможности совместного использования обеих методов с целью повышения эффективности управления в строительстве. Результаты исследования показали, что большинство принципов, лежащих в основе концепции бережливого строительства, согласуются с принципами и методами информационного моделирования сооружений (восемь из них – полностью, четыре – частично, четыре – не согласуются). Авторы систематизировали преимущества совместного использования принципов обеих концепций в области управления проектами (качество проекта, риски, затраты, время, масштаб, человеческие ресурсы, коммуникации, снабжение и управление со стороны участников). Результаты исследования могут быть полезными для развития в России, как для дальнейших научных исследований, так и для практиков, управляющих проектами, а также для других специалистов строительных профессий.

Ключевые слова: BIM; принципы бережливого строительства; управление проектами; строительство; совместное использование; преимущество.

Whereas lean construction and Building Information Modeling as concepts and as practices have been under spotlight of academics, building companies, consultants, investors and IT specialists about last two decades, 'there has been hardly any interaction between these two camps', according to Lauri Koskela [3]. Regarding construction industry in Russia, we are now witnessing the boom of popularity of BIM both among government authorities and private companies. This has led to the start of legislative regulation in the sphere of BIM (as well as other

technologies of information modeling) application in construction. However, there has been any attention paid to lean construction concept in our country. Thus, it makes research on benefits of BIM and lean construction interaction even more relevant.

Initially the idea of possible synergic use of lean principles and BIM has developed in US less than ten years ago. There advocates of that idea studied in detail the interconnections between lean concept and BIM and also provided initial proofs. But, in our opinion, the problem is that,

as it was mentioned below, lean construction concept hasn't gained enough development in Russia. Moreover, talking about lean construction we imply the phase of construction itself, which is only one of the four phases of any construction project. However, up to now BIM has been used mostly for needs of design and pre-construction periods while delivering a construction project. Thus, the possible application of BIM and its benefits namely for construction and for construction projects in whole have not been studied fully yet.

Before going further, let us provide some initial definitions to better carry out this research. Starting with lean construction, it is worth mentioning that it is an innovative management concept and approach which was created by translating success of Toyota Production System to construction industry and whose core principles are:

- creating value for clients;
- removing (or at least reducing) waste (in processes, in information communication and literal construction waste);
- providing smooth flow of operations at construction site [5, p. 7].

Apparently, all these is supposed to cause less construction costs, higher revenue and business value. BIM being a tool for visual modeling of building's design [6, p. 45] and construction process can be applied to bring the principles of lean construction concept to life. Some researchers use even the term 'lean BIM' to highlight the concept of integrated use of BIM and lean construction principles which provides more synergic benefits than each concept itself.

As a building can be constructed virtually with the use of BIM it helps to integrate design and construction stages of any construction project more smoothly avoiding any mistakes and discrepancies that might occur. Thus, the results of planning become more accurate and concrete with the use of BIM. This happens because building designers can make any amount of design iterations (within the project budget) with the use of BIM to reach the optimal (according to the chosen criteria for the project considered) design features for the building.

Application of BIM in interests of lean construction also may lead to more ecologically friendly construction (less environmental waste) as even carbon footprint of the design can be in-

stantly analyzed through BIM. Thus, BIM asserts the least possible environmental impact from a building's existence, and makes it more operationally efficient for its owners throughout the building lifecycle. It also 'streamlines the building lifecycle processes to provide a safer and more productive environment for its occupants' [1, p. 102]. As a result, BIM can also be used for cost estimation, sustainability measurements, facility management, etc. [7].

What is more, BIM enables some lean processes such as collaborative planning and first run studies (especially for innovative and technologically complex projects). In addition to this, Martin Brown [2] points out one more significant benefit from combined use of BIM and lean principles — 'getting closer to the Honda expression of "everything we do goes into everything we do", while currently only 40–60% of what we do in construction goes into what we do, i.e. what we get paid for'.

Considering all benefits of combined Lean and BIM application and taking into account the methodology of project management we have systematized in more detail the opportunities of bringing to life principles of lean construction with the use of BIM (see Table 1):

As it can be seen from the table 1, 50% of lean principles can be fully realized with BIM, 25% — partly, and only another fourth of them — none. Furthermore, we aimed to make that more tailored for project managers so that they can definitely see the benefits of LeanBIM in every project management activities they do. Basing on the research results presented in table 1 above and using project management fundamentals covered in Project management body of knowledge [2, p. 61], we have widened and specified the benefits mentioned above for the existing project management fields (see figure 1):

So, following the principles of lean construction and using BIM provides project managers with the opportunity to:

- enhance team-wide collaboration,
- eliminate all types of waste,
- increase efficiencies of construction projects.

This inevitably should lead to overall improvement of business performance in construction industry. Below we have developed the consecutive linkage from lean construction principles to impressive BIM capabilities to effectively achieved project management goals and,

Table 1. Lean construction principles enabled with BIM use opportunities

Area	Principle of lean construction	Possible to do it with BIM	How it is done with BIM	Project stage
Flow process	Reduce variability	+	evaluation of different alternatives and detailed planning of construction process through visualization	pre-construction and construction
	Reduce cycle times	+	effective time and processes planning through visualization and evaluation of different alternatives	
	Reduce batch sizes	+/-	rapid generation and evaluation of different alternatives and detailed planning of construction process through visualization	
	Increase flexibility	+	Rapid generation and evaluation of multiple design and construction alternatives (especially when facing uncertainties and risk situations)	design, pre-construction and construction
	Select an appropriate production control approach	+/-	Evaluation of different alternatives and detailed planning of construction process through visualization	
	Standardize	+	detailed planning and collaboration at design and construction stages through visualization, integration of information models at different project phases	
	Design the production system for flow and value	+/-	detailed planning of construction process through visualization which leads to higher value of buildings for clients	
	Use visual management	+	Visualization of processes, visual evaluation of alternative decisions	all stages
	Institute continuous improvement			
	Value generation process	Ensure requirement flow-down	-	-
Ensure comprehensive requirements capture				
Focus on concept selection		+	visual evaluation of alternative concepts	design
Problem-solving	Verify and validate	+	Rapid generation and evaluation of multiple design and construction alternatives (especially when facing uncertainties and risk situations)	design, pre-construction and construction
	Consensus, consider all options	+	online/electronic object-based communication, visual evaluation	
Developing partners	Go and see for yourself	+/-	See and check changes through multidimensional information model (instead of visiting the building site itself)	pre-construction and construction
	Cultivate an extended network of partners	-	-	-

project quality and scope management	<ul style="list-style-type: none"> • focusing on client value from the beginning up to the end of project
project time management	<ul style="list-style-type: none"> • lean and predictable sequencing
project cost management	<ul style="list-style-type: none"> • reducing unnecessary costs
project stakeholder management	<ul style="list-style-type: none"> • increasing value for clients
project risk management	<ul style="list-style-type: none"> • rapid visual valuation of changes and alternatives which enables rapid reaction to risk situations
project communications management	<ul style="list-style-type: none"> • improving information flow and communications between project partners and supply chain, project team members and managers, etc.
project human resources management	<ul style="list-style-type: none"> • standardised and controlled flow of project team members • less stress and smooth work of project team
project procurement management	<ul style="list-style-type: none"> • enabling just in time supply of materials • lean and predictable material sequencing

Figure 1. Specified benefits of LeanBIM for project management fields

finally, to higher business value for construction companies (see Figure 2):

Apparently all these lead us to the conclusion that integrated implementation of Lean and BIM in building companies, design firms, suppliers etc. should take place in nearest future to solve many accumulated problems the construction industry faces when it comes to project management. For example, according to statistics, project managers of high-end projects spend up to 60% of their time managing client changes and

giving instructions to other project participants rising from the need to implement these changes [5, p. 23]. And many other problems in project management can be listed here. But as in any cases of introducing changes there are always some obstacles. M. Younes points out these most tough challenges while implementing integrated Lean and BIM methodologies into project management in construction (see Figure 3) [8, p. 56]:

The figures above are taken from an international research, however, they seem quite the

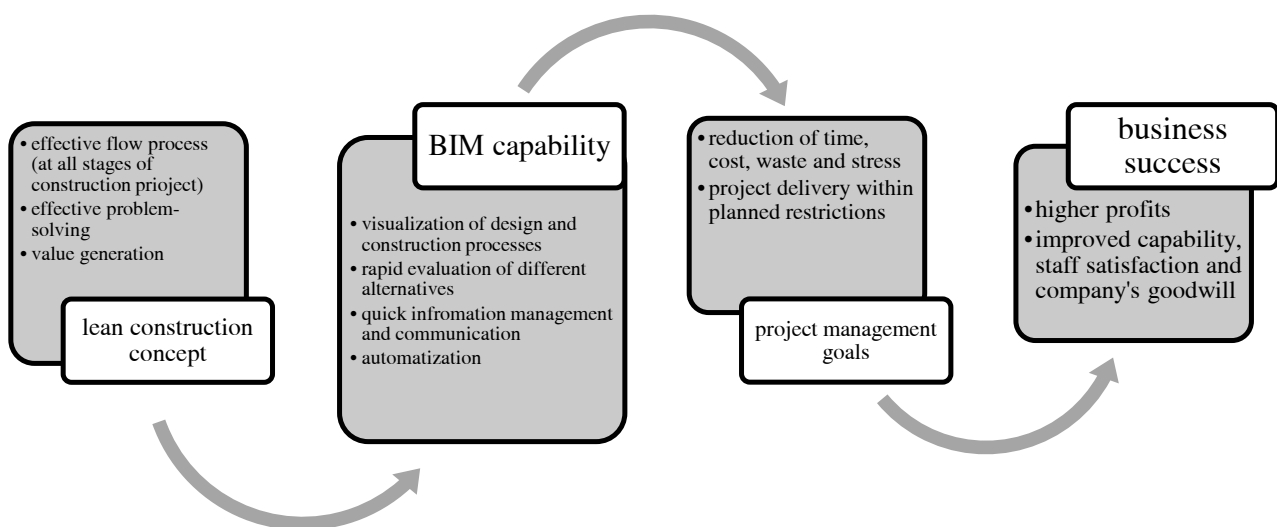


Figure 2. Consequent linkage 'Lean-BIM-project management-business success'

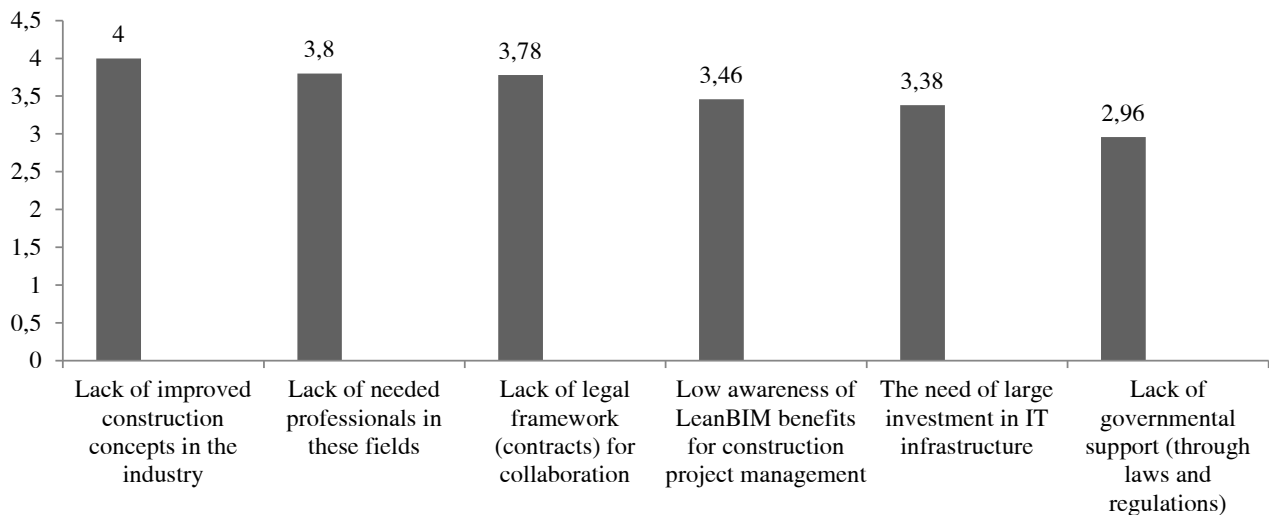


Figure 3. Gradation of challenges facing while implementing LeanBIM in construction project management

same for Russia. Actions to be taken for effective implementation of LeanBIM are also the same no matter which country we are talking about. To effectively implement both BIM and Lean, the following should be in place in any case:

- construction leadership at organization and at project level;
- contracting processes shaped around Lean and BIM requirements;
- people's (contractors, suppliers, stakeholders, other participants, etc.) collaboration mindset and real involvement in project short-term planning and improvement.

Finally, lean processes facilitate the implementation of BIM. Lean is characterized on one hand, by predictability and discipline, and on the other hand, by collaboration, learning and experimentation. All these features are very worthwhile in the implementation of BIM. Thus, the implementation of BIM should not be thought, presented or organized as a stand-alone initiative — all the efficiencies inherent in BIM can hardly be pressed out without embedding modeling within a lean construction environment. Conversely, in companies and projects with mature lean construction implementation, BIM should be positioned as another lean tool.

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Managing the Demographic Risk of Pension Systems

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Abstract. Demographic changes observed at present on the European markets strongly determine the sustainability of pension systems. The most important changes in this context include: increase of life expectancy, decline of fertility rate, ageing of societies, and migration flows. All the above trends pose a major risk, mostly for public pension systems that finance the distribution of retirement benefits from mandatory contributions collected from earners in the working-age population. Pension policies should be designed to minimize the demographic risk and limit the risk of old-age poverty. The risk of longevity, associated with the steady increase of life expectancy rates, is another important aspect to be managed by all institutions involved in effective distribution of pension benefits, be it from the base part of the pension fund or any supplementary funds. This paper aims to emphasize the significance of demographic risk in a pension system, identify the types of demographic risk and the associated risk management methods, and to present the projected impact of demographic risk upon the replacement rate.

Keywords: pension system; demographic risk; longevity bonds; replacement rate.

Управление демографическим риском в пенсионных системах

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Аннотация. Демографические изменения, которые наблюдаются в европейских странах, жестко регламентируют устойчивость пенсионных систем. Наиболее существенными изменениями в этом плане являются: рост продолжительности жизни, падение коэффициента рождаемости, процесс старения общества, направления миграционных потоков. Указанные изменения создают основные риски, особенно для публичных пенсионных систем, распределяющих пенсионные накопления из средств, отчисляемых работающим населением. Пенсионная система должна минимизировать риски и ограничить риск попадания пожилых людей в зону бедности. В статье подчеркнута значимость анализа демографических рисков для пенсионных систем, идентифицированы типы демографических рисков и связанных с ними методов управления рисками, а также представлен прогноз влияния демографического риска на коэффициент замещения.

Ключевые слова: пенсионная система; демографический риск; долговечность; коэффициент замещения.

1. INTRODUCTION

It seems that the present demographic changes observed on European markets have already made a notable impact upon the operation of public pension systems in practically all countries of the region. The most vulnerable elements of the system are the so-called base funds, i.e. those funded from mandatory pay-as-you-go contributions collected from the working-age earner population. However, the supplementary part of the pension system — funded from voluntary contributions declared on an individual base — is also fairly susceptible to the effects of demographic changes. Within the present framework of a supplementary pension plan, the sums collected from present earners are not used to cover the outstanding pension claims, but invested on the market. This part, together with accrued interest, is stored on individual pension accounts, to be returned to the contributor at retirement, in the form of supplementary pension instalments. Thus, depending on the adopted form of financing, the demographic changes will exert a greater or lesser impact upon the volume of benefits paid by the system.

Taking into account the fact that retirement benefits covered from the mandatory part of the pension system (i.e. from public retirement plans) represent the main source of income for the ever-increasing population of old-age pensioners in Europe [1, p. 5], it seems that retaining an adequate level of pension benefits is a major challenge for both the pension systems and the national health insurance systems. The most important problem to be faced is how to reconcile the need for retaining long-term stability of the pension system (with no detriment to public finance or to realization of other socially vital objectives, such as education or housing policy) with the equally essential need of retaining the adequate (socially acceptable) level of pension benefits paid [2, p. 442].

This paper aims to emphasize the significance of demographic risk in a pension system, identify the types of demographic risk and the associated risk management methods, and to present the projected impact of demographic risk upon the replacement rate.

2. THE PRESENT DEMOGRAPHIC SITUATION OF THE EUROPEAN MARKET

Demographic fluctuations and development trends exert a considerable impact upon the stability and sustainability of European pension systems. The most important determinants of the present demographic situation include the following:

- life expectancy
- fertility rate
- old age dependency ratio
- migration flows.

The most notable change in this context is the steady increase of at-birth life expectancy in European countries observed from 1960 onward (Figure 1). In the years 1960–2013, the highest rates of life expectancy at birth were reported for Spain, Italy (an increase of more than 13 years), France (ca. 12 year), Switzerland, Germany, Greece, and Slovenia (more than 11 years). All the above countries are fairly affluent, with average income levels decidedly higher than those in Central and Eastern Europe. Slightly lower at-birth life expectancy increases were recorded for Sweden, the Czech Republic, Poland, and the United Kingdom. This trend may be associated with geographic location (Sweden and the UK) or the level of economic development (Poland and the Czech Republic). It may be useful to note that, in 2013, the longevity rates were the highest for Switzerland, Italy, France, Spain, and Sweden.

The available projections of life expectancy at birth suggest a continuous growth trend in Europe; by 2060, the projected life expectancy at birth in male population will increase by an average of 7.2 years (reaching 84.7 in 2060). For females, it is projected to increase by 6.0 years, reaching 89.1 in 2060 [3, p.13]. This represents a significant increase in the total projected duration of retirement. If this projected increase is not balanced by a respective increase of the saved pension capital (both from the mandatory and the supplementary plans), the value of paid benefit instalments will decrease in time.

Another important factor to be considered here is the fertility rate, a measure of simple replacement of generations. On average, the total fertility rate at replacement should exceed 2.1. Lower index values lead to an increase of ageing across population, resulting in rapid depopula-

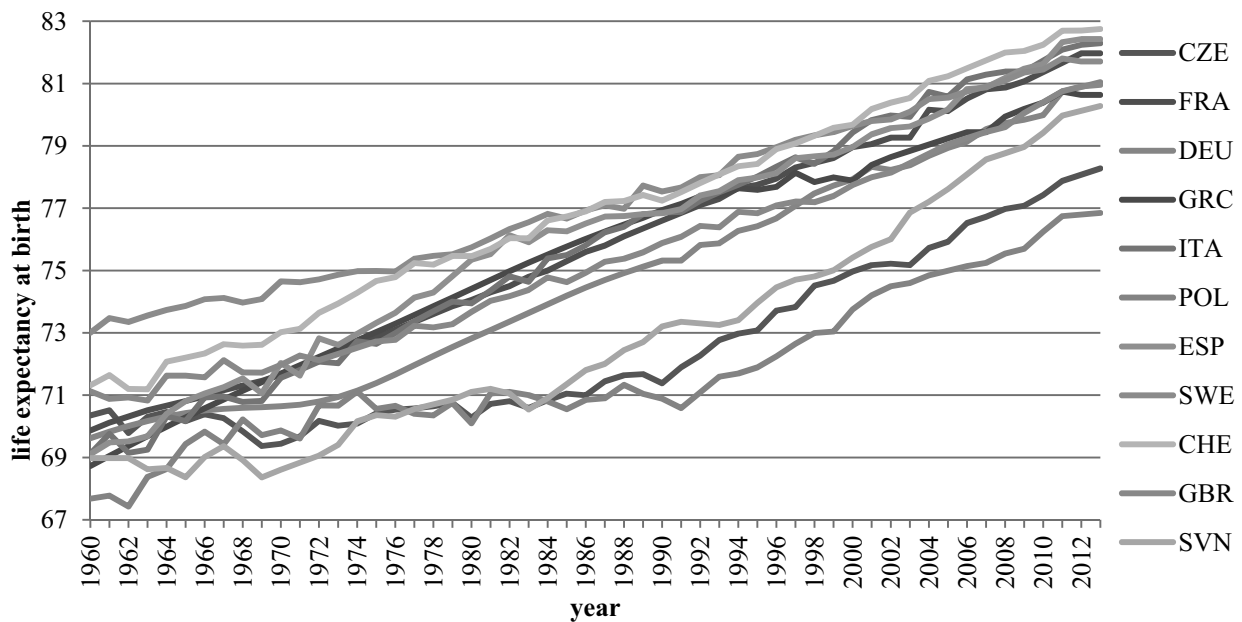


Figure 1. Life expectancy at birth in the selected European countries, in the years 1960–2013

Source: Based on www.data.worldbank.org.

tion. As such, they pose a significant risk mainly to the public (base) pension systems. A decrease in the number of active earners, coupled with the increase in the number of pension beneficiaries past their retirement age will gradually exert pressure upon public finance to increase state budget support for pension systems.

As shown in Figure 2, the years 1960–2013 brought a significant decline of fertility rates for all the European countries under study. Simple generational replacement threshold has not been recorded in any of the countries under study ever since the second half of the 1990s. In the year 2013, the highest fertility rates were registered in France, Sweden, and the United Kingdom; and the lowest – in Greece, Poland, and Spain.

The available projections of fertility rates suggest a steady growth of the average fertility rate for the whole European market (up till 2060, at least). Similar rising trends will also be registered on national level by most of the European countries. However, all of the projected national rates for European countries are reported well below the threshold of 2.1 [3, p. 10]. Therefore, national policies of individual European countries should place proper emphasis on promoting family friendly instruments, designed to stimulate the rise of fertility rates, at least to the level that offers simple generational replacement, with the purpose of lessening the financial

burden of pension systems upon the national budget.

Another important factor to determine the sustainability of base pension systems is the old age dependency ratio, calculated as a ratio of population past the age of 65 to the working age population (i.e. between the age of 15 and 64). The rising trend of this ratio suggests a growing financial pressure from pension systems upon the national budgets. For every European country under study, over the span of 1960–2014, the values of old age dependency ratios were on the rise (Figure 3). In the year 2013, the lowest ratios were registered in Poland, Slovenia, and the Czech Republic. Those countries represent developing economies, meaning that their affluence levels are still below the Western Europe averages. Therefore, it can safely be assumed that their family models and perceptions are also different, at least to some extent.

It must be noted that the projected development trends of the old age dependency ratio are quite alarming. For some countries of the region (e.g. the Czech Republic, Greece, Slovenia, Romania, Slovakia, Portugal, Poland), the projected old age dependency ratio values in the year 2060 will be past the 50% threshold [3, p. 28]. If the forecasts are accurate, the resulting problems in financing the increased burden from the base part of their pension systems may prove unbear-

able, before we even take into account the rapid increase of public health expenditure needed to sustain the ageing societies.

Migration flows are last on the list of the most important demographic factors to affect the sustainability of pension systems. The negative values of the migration flow balance (calculated as difference between the numbers of permanent outflow to permanent inflow) present a detriment to the pension systems, particularly

when the majority of the permanent migration outflow are persons in their productive (and reproductive) age. Based on the available data, it may be interesting to note that Poland was the only country of the region to register negative migration balance values for the whole duration of the period under study (2000-2013). Negative values were also registered in Spain from 2009 onwards (Figure 4). These are typically attributed to labour market specificities. In Spain, the

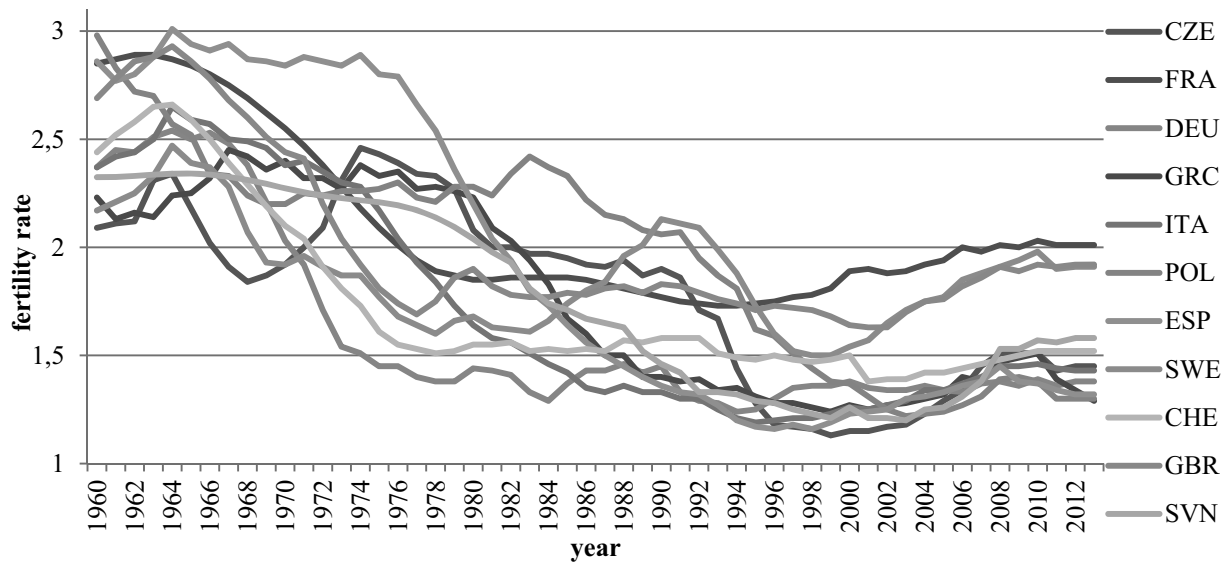


Figure 2. Fertility rates in selected European countries, in the years 1960–2013

Source: Based on www.data.worldbank.org.

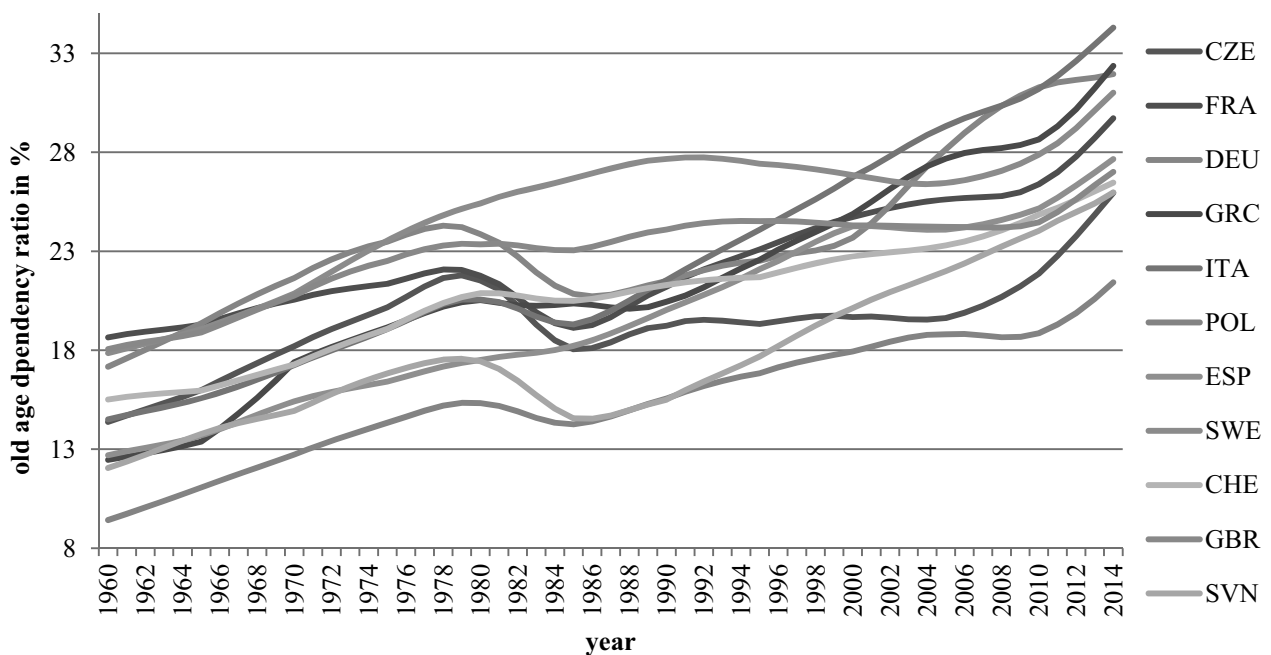


Figure 3. Old age dependency ratios for selected European countries, in the years 1960–2014 (in %)

Source: Based on www.data.worldbank.org.

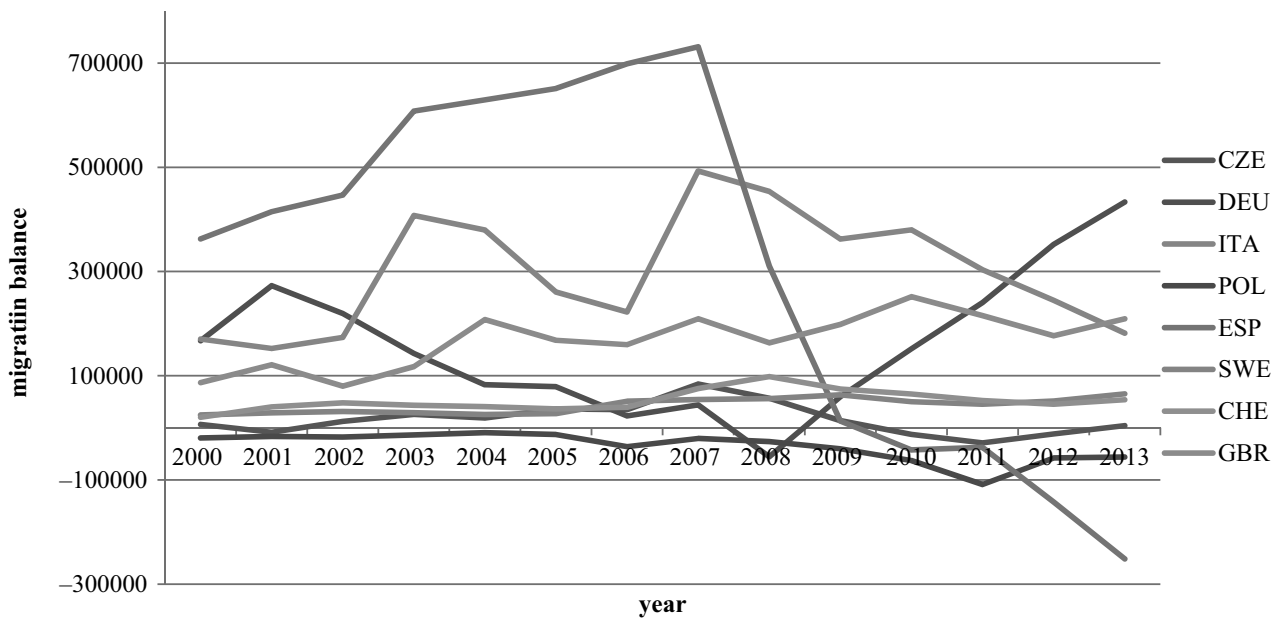


Figure 4. Migration balance for selected European countries, in the years 2000–2013 (in the number of persons)

Source: Based on data from Population Database Eurostat.

unemployment rate rose from 17.9% in 2009 up to 26.1% in 2013; and Polish wages are among the lowest in the region.

The above trends in the development of major demographic determinants of public pension system operation suggest that many countries of the region will soon be forced to redesign their existing pension systems. Some of them have already initiated certain instruments, such as the extension of the formal retirement age thresholds.

3. THE NATURE AND THE SIGNIFICANCE OF DEMOGRAPHIC RISKS, IN THE CONTEXT OF PENSION SYSTEMS

The significance of demographic risks in a pension system stems from the need to finance current benefit expenditures from current income (mainly from monthly contributions from earners on the market, but supplemented by fiscal sources in case of deficits). As a result of the ongoing demographic changes (both existing and anticipated), the relation of expenditures to collected contributions is subject to fluctuations. Assuming the consistency of tax rates and pension system contributions, the best measure of demographic risk is the num-

ber of persons contributing to the system (paying earners) and the number of persons receiving their pension benefits. Based on the above approach, demographic risk applies mainly to the base (public) part of the pension system and, as such, is a risk borne by the state as the sole party obliged to provide material support for the retired.

Data presented in the previous section, particularly the growing trend of the old age dependency ratio for all European countries under study, suggest that detrimental effects of demographic changes are unavoidable, and – for some European countries – already well underway. To counteract them, state authorities need to increase the effective contribution rates or accept the consequences of decline in the level of pension benefits distributed among the entitled population. It must be remembered, however, that either of the above scenarios can only be implemented on a limited scale. Each state is formally obliged to provide minimum living standards to their citizens – this means that the reduction of benefits paid to pensioners should not decrease below a certain threshold. Similarly, the increase of mandatory contributions from earners cannot go past a certain level without detriment to the cost of labour or consumption patterns in the household segment.

Following this line of reasoning, one can expect that demographic risk will soon generate the risk of poverty in the elderly population. Two separate notions must be defined in this context (for more details, see: [4, p. 114], [5, p. 2]):

severe material deprivation — represents an enforced inability to sustain basic cost of existence, bearing the risk of gradual deterioration of biological functions

relative poverty — represents a situation where total household disposable income falls below the poverty threshold, calculated at 60% of the national median disposable income level (See: http://ec.europa.eu/eurostat/statisticsexplained/index.php/People_at_risk_of_poverty_or_social_exclusion).

Considerations contained herein apply to the financial situation of the elderly population. Persons in this segment rely on their income in the form of retirement pensions, which are typically well below the level of their individual earnings at the moment of take-up of pensions. Incidentally, medical expenses in this segment constitute a large part of their household budgets. Pension reductions, coupled with the mounting cost of health maintenance, may generate the risk of poverty in this segment.

With severe material deprivation cases, the key obligations are borne by the social security system. Persons with enforced inability to sustain their basic needs are entitled to receive material support from the social security system. However, this form of support is funded from the state budget. Consequently, the larger the population of the materially deprived, the greater is the financial burden imposed upon the state budget.

Women are particularly vulnerable to poverty risk, with their markedly higher longevity projections and notably lower average retirement pensions compared to men. Female earners over the course of their working lives receive lower earnings and their pension system contributions are set at a correspondingly lower level, resulting in lower pension capital used as basis for the calculation of pension benefits (for more details, see: [6, p. 49]).

Another important type of demographic risk to pension systems is the *longevity risk*, i.e. the risk of pay-out ratios going past the expected margin. This type of risk applies both to public pension systems and to institutions involved in

supplementary pension plans. It must also be noted that longevity risk may apply both on individual level and that of whole generations.

Specific (idiosyncratic) longevity risk arises from the fact that an individual beneficiary of the pension system may live much longer than expected based on mortality statistics. This type of risk is particularly elevated for persons using supplementary pension schemes based on clear declarations of pay-off periods. Such persons face the risk of living past the declared time-frame, or — more specifically — losing a large part of their household income, which may lead to drastic deterioration of living standards and hamper their ability to satisfy the most vital needs. Since the determination of pay-off periods is made in tandem with institutions directly involved in supplementary pension plans (insurers, banks, pension funds), they are expected to provide some form of support for their clients in the process.

Longevity risk may also apply to whole generations or cohorts. This type of risk, referred to as *aggregate longevity risk*, reflects the unforeseen changes in average life expectancy of whole age groups. The effects may be two-fold. If the projections prove undervalued (for example, with high incidence of untimely deaths due to civilizational diseases) the risk of undervaluation of the pay-off total is borne by the beneficiary. However, with positive changes in mortality rates (resulting in increased life expectancy), the risk is carried over to the insurer. This type of longevity risk applies mainly to institutions that take up lifetime pension obligations. This means that aggregate longevity risk applies both to base (public) and supplementary pension schemes.

Some authors introduce the term *total longevity risk* as reference to the combined effects of idiosyncratic and aggregate longevity risk [7, p. 2].

In view of the demographic trends presented in earlier sections, it may be assumed that the risk to pension system sustainability will soon affect all countries under study (if not already manifested).

4. METHODS FOR MANAGING DEMOGRAPHIC RISK

Demographic risk management of public and state-supported (mandatory) part of a pension system can be obtained through (see: [1, p. 11–14]):

- increasing pension eligibility ages; prolonging the average period of work activity offers the prospect of increasing the pension capital used in the settlement of existing obligations
- increasing the mandatory contribution rates, with the intention of raising the pension capital for all participants of the public part of the system
- limiting and restricting the access to early retirement schemes (offered to certain vocational groups), with the intent of delaying the payout maturity combating of gender inequalities in the distribution of pension benefits.

All of the above solutions have potential for increasing the average level of pension benefits received by the participants and should be regarded as justified, due to the steady increase of life expectancy rates. However, it must be noted that practical implementation of these methods should be accompanied by other measures in support of prolonged work activity periods, particularly in the realm of health care provision, workplace organization and employment. Without this type of support, the effects of demographic risk management solutions may prove inadequate (for example, when the increase of pension eligibility ages results in a sizeable increase of other types of claims: unemployment benefits, disability allowances and welfare payments).

Apart from purely systemic solutions, the European countries should also consider extending their family support policies, with the view of increasing the fertility rates and — consequently — the aggregate volume of pension scheme contributions collected from earners in the future. This should also be accompanied by well-designed migration policies and other instruments that offer greater incentives for earners (particularly the young generations) to seek gainful employment in their home country.

Decidedly different methods and instruments of demographic risk management apply to financial institutions involved in provision of supplementary pension plans. Here, the range of applicable methods is largely defined by the business model (banking, insurance).

Life insurance companies that offer endowment funds, unit-linked life insurance schemes and (in some European countries) perpetuity plans based on equity release may adopt a range of instruments for managing their longevity risk,

such as reinsurance and alternative risk transfer (see: [8, p. 198]). Both solutions are derived from methods used widely in non-life insurance policies, particularly in the reduction of catastrophic-type risks — both natural and those induced by human action.

A good solution in the area under study is securitization. Two strategies are viable in this context: direct (local) and indirect (external). With direct securitization, the risk is transferred by the insurer (in granter capacity). As a rule, the insurer is the sole issuer of securities, and the funds obtained from their sale are invested in risk-free instruments for the duration of the transaction. This type of securitization strategy is typically conducted with support from a banking institution, acting in their advisory capacity (both floating and sale). In contrast, the indirect securitization — a decidedly more popular solution — involves creation of an independent company to take over the risk based on conventional reinsurance contracts and supplemented by profits from simultaneous sale of securities [9, p. 39].

The longevity risk may be managed through the use of various types of longevity bonds. Two major categories of longevity bonds can be distinguished: those with pay-outs linked to mortality rates and those linked to survivor rates (i.e. generating the flow of funds until the death of the last representative of the target population) (see: [10, p. 168], [11, p. 37]).

Apart from longevity bonds, insurers may transfer their longevity risk using other hedging instruments, such as the survivors swap forward transactions (the so-called q-forwards, with «q» representing a symbol used by actuaries to denote mortality rates). Both instruments are well-defined in professional literature. Dowd K. *et al.* define survivor swap as: “a swap involving at least one random mortality-dependent payment” [12, p. 2]. Coughlan G. *et al.* define q-forward as: “an agreement between two parties to exchange at a future date (the maturity of the contract) an amount proportional to the realized mortality rate of a given population (or subpopulation), in return for an amount proportional to a fixed mortality rate that has been mutually agreed at inception” [13, p. 2].

Considering the fact that the public part of a pension system represents a life-long obliga-

tion, the institutions involved in distribution of this part of pension benefits may, just like their commercial counterparts, make good use of the above methods for hedging their longevity risk.

5. THE IMPACT OF DEMOGRAPHIC CHANGES ON THE REPLACEMENT RATE VALUES

The demographic changes presented in earlier sections of this paper will clearly affect the payout of pension benefits, particularly those associated with the base part of the pension system. Regardless of the adopted policies and methods for hedging the demographic risk, the resulting replacement rates will follow a steadily declining trend. Table 1 presents net theoretical replacement rate values (as a ratio of the net retirement pension to the net individual earnings at the moment of take-up of pension) for selected European countries, both factual (2010) and projected (2050). Data presented in Table 1 suggest a steady decline of net theoretical replacement rate for all the countries under study bar Germany. The most pronounced decrease trend can

be seen for Greece, Poland, Romania and Czech Republic. Those all represent developing economies of Central and Eastern Europe characterized by the highest population ageing rates. This means that their pension systems should employ particularly stringent and exigent methods for hedging their demographic risk.

6. CONCLUSIONS

The above considerations seem to emphasize the clear and present need to respond to demographic risk in the context of pension systems. This problem should be tackled both by institutions involved in servicing the public part of the pension system and by other financial institutions providing supplementary pension schemes on commercial terms. It is also clear that many European countries still face the need of reforming their existing pension systems if they intend to reduce the risk of poverty in the elderly segment of the population. The supplementary part of the pension system plays an important role in this context, and may be key issue to warrant adequate levels of future aggregate income for pensioners.

Table 1. Net theoretical replacement rates for selected European countries in 2010 and in 2050

	2010	2050
Czech Republic	70,6	43,1
France	77,6	58,8
Germany	59,1	63,7
Greece	121,3	87
Italy	89,5	69,1
Poland	75,5	43,3
Spain	94,5	86,5
Sweden	60,3	53
United Kingdom	77,2	75,1
Slovenia	59,2	53,7
Latvia	80,4	55,3
Portugal	85,8	65,9
Romania	70,7	45

Source: Based on data from: http://ec.europa.eu/europe2020/pdf/themes/04_pensions.pdf.

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Restructuring the Banking System: the Case of Vietnam

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Abstract. This paper aims at studying the restructuring of commercial banks that has been started since 2008 in Vietnam by analysing in two angles: Efficiency and Stability of the banking system. Firstly, the paper applies a modified Data Envelopment Analysis (DEA) model in 2 cases to estimate the changes of the efficiency by analyse the E-scores of 26 commercial banks from 2008 to 2012 and examine the profits and productions efficiency of 7 DMUs of the Vietnamese banking system in 2 years 2011 and 2013. Secondly, this study will calculate the Z-scores and T-test by using SPSS program to assess the stability of the banking system. Moreover, this study uses quantitative and qualitative methods to assess and quantify the results of the Vietnam commercial banks' restructuring under the Decision No. 254/QD-TTg. The results showed that Vietnamese banking system remained stable during the process and contributed to economic growth, however the results were quite limited and lacks of long-term effects, such as many restructuring objectives were not achieved thorough handling bad debt, cross-ownership, improving governance and enhance the operational efficiency of commercial banks. In particular, the major cause of these problems is due to the lack of a general approach to the overall handling of the issue of restructuring commercial banking system, particularly is missing a legal framework for the systematic implementation of the restructuring process in the context of economic restructure.

Keywords: Restructuring; banking system; performance; efficiency; stability; data envelopment analysis (DEA); Vietnam.

Реструктуризация банковской системы: пример Вьетнама

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Аннотация. В статье проанализирована реструктуризация коммерческих банков, начатая во Вьетнаме в 2008 г., с двух точек зрения: эффективности банковской системы и стабильности банковской системы. В двух случаях применена модифицированная модель анализа среды функционирования (АСФ) для оценки эффективности изменений с помощью анализа E-рангов 26 коммерческих банков в период с 2008 по 2012 г. Проанализированы прибыль и эффективность 7 DMU банковской системы Вьетнама в период с 2011 по 2013 г. Рассчитаны Z-ранги и T-тест для оценки стабильности банковской системы с помощью программы SPSS. Для оценки результатов реструктуризации банковской системы в соответствии с распоряжением № 254/QD-NNg применены как количественные методы оценки, так и качественные методы. Результаты анализа показали, что банковская система Вьетнама остается стабильной, содействует экономическому

росту, хотя некоторые цели реструктуризации не были полностью достигнуты, например проблемы безнадежных долгов, перекрестного владения титулами собственности, повышения уровня управления, улучшения эффективности оперативной деятельности банков.

Ключевые слова: реструктуризация; банковская система; результативность; эффективность; стабильность; анализ среды функционирования (АСФ); Вьетнам.

INTRODUCTION

In the trend of globalization and international economic integration, the banking system's operations play a key role in the stability and development of the economy. According to Claessens (1999), bank restructuring aims to organize, enhance governance of CBs to ensure the safety of the system and create a strong financial, capable of risk managements and goods management system of CBs. The study of Waxman (1998) showed that restructuring banks often is conducted whenever there is evidence of one or more banks' inability to pay more than 20% of total deposits throughout the banking system and the need to have a package of measures related to institutional and legislation to deal with weak banks and bring the banking system back to a sustainable and healthy state.

Vietnam is increasingly integrated into the international economy, since the financial markets have gradually interconnected so instabilities in one country also have impacts on others. Restructuring the banking system is a complex problem not only in the banking sector, but also for the economy. Vietnam — a developing country should have the review and evaluation of the measures appropriate to the conditions and circumstances of the country follow the steps in the restructuring of the banking system from international experience. In Vietnam, the growth of the economy has had a strong impact on the development of the banking system from 2001 to 2015. The quick economic growth, especially in the application of modern science and technology has boosted the banking system to develop rapidly in both scale and service qualities. However, with the rapid development, the banking system has potential risks such as high credit and liquidity risks, instability, underperformance, lack of competitiveness, and inadequate governance capacity. In addition, interest groups and cross-ownership between the big banks created mutual dependence and high

risk systems. Therefore, if the risks and weaknesses are not processed promptly, it will have a negative impact on macro-economic stability and national financial system. Therefore, the restructuring of the banking system and financial institutions is imperative to avoid the collapse of the banking system and economy.

The system of credit institutions in Vietnam have 3 State — owned commercial banks, 34 Commercial banks, 5 Wholly foreign owned banks, 4 Joint — ventures banks, 2 Policies banks and 1 cooperative bank (for more detail see Appendix 1). With a total number of 38 banks, the commercial banks are playing a leading role in Vietnam's banking system and are the main object of the process of restructuring the banking system in the period 2008–2014. Therefore, the study evaluated the results of the banking system before and after the restructuring will also focus on the aforementioned banks.

Under the scope of research subjects, the research answers four main questions:

(i) *How effective and stable were the banking industry's performance after restructuring process?*

(ii) *What are the main aspects of Vietnam banking restructuring process? (For example, legal framework, policies, measures...)*

(iii) *What are the effects after restructuring the banking system in Vietnam in the period 2008–2012?*

(iv) *What are the targets to improve the banking restructuring process in Vietnam in 2015–2020?*

The purpose of this study are: (1) explore the advantages and disadvantages in the process of restructuring the banking system; (2) review the implementation of the objectives and measures to restructure under the scheme “Restructuring the system of credit institution in 2011–2015”, which is issued under Decision No. 254/QĐ-TTg dated 01/03/2012 (see more in Appendix 9); (3) evaluate the effectiveness of methods of restructuring the banking system in Vietnam in recent years. This study approaches from the perspec-

tive of the method of restructuring the banking system, thereby assess the efficiency and stability of the restructuring measures already implemented by using the DEA model and calculate Z-scores with T-test by using SPSS program, then draw the successfully, limit institutions and causes. Combined with the study of international experience and the reality in Vietnam, this study has suggested some policy recommendations to the authorities and banks in order to continue the process of restructuring the banking system effectively in the future.

Consequently, this study will focus on assessing the situation the processes of restructuring the banking system of Vietnam, through the layout of the study are as following: section 2 provides the rationale for restructuring the banking system in Vietnam. Section 3 presents the methods and models specification. Section 4 analyzes the empirical results and Section 5 gives the conclusion.

THE RATIONALE FOR RESTRUCTURING BANKING SYSTEM IN VIETNAM

The reasons for Vietnam's banking system restructuring can be explained by following: (1) Vulnerability of Vietnam's banking system (such as increasing risk of bad debts; poor quality of governance, technology and human resources; liquidity risk, institutional risk, credit risk...); (2) Not really effective performance (of the banking system and its impact on the whole economy); (3) Requirement of global integrity (for example, internationalization, international standards, competitiveness, reactions to external shocks...); and (4) Requirements of new stage of Vietnam's socio-economic development (like high-quality, effective, social-economic and environment sustainable development).

In Vietnam, the market conditions that has not really developed, Vietnam is considered as a bank-based economy. Vietnam's banking system in recent years has grown rapidly, with total assets of more than 1.5 times the GDP at the end of 2014; total credit to the economy to around 100% of GDP, satisfy the development demand of the country. However, the sudden explosion of both scale and the diversity of the banking system in a short time have potential risks and impacts significant risk to the safety and sound-

ness of the entire system. In particular, since 2011, the banking system began to show signs of tensions and accumulation of vulnerability factors, bad debt tends to rise sharply, after a process of increasing the pace of credit expansion for the economy along with the weakness of the corporate sector and the general decline of the economy. Before the restructure, the banking system in Vietnam met many problems that can be summarized in the **Table 1** below:

In other words, it could be concluded the difficulties and risks in restructuring in Vietnam's banking system are followings:

Firstly, risk of long-lasting restructuring for there is lack of legal framework, scientific basis (data base...) and institutional capacity for restructuring the banking system (like schemes of resolving assets).

Secondly, risk of dependence on foreign banks: the number of banks in short of liquidity and with bad assets is quite large in the banking system; the number of good banks which is capable of acquiring others is much less than the number of bad banks. The national financial and monetary security.

Thirdly, risk of public confidence erosion. State-owned banks may have implicit guarantee for depositors. Meanwhile, that the Government declares not to insure private banks may lead to bank runs, or closures of some banks can lead to doubts of soundness of other banks in the system.

Fourthly, risk of interest conflicts arising in the restructuring process. They are conflicts of interests of depositors, different groups of shareholders, banks, and borrowers...

Fifthly, risk of costs arising in the restructuring process and tolerance of the economy. The study of Dickle, P. (1999) has shown that costs of the restructuring can occupy from 20 up to 50% of GDP if the restructuring occurs after crisis. More specific, his results shown that 20% of GDP in Korea, over 30% in Thailand and over 50% in Indonesia.

The system of CB in Vietnam grows rapidly in quantity and sources of equity after the renovation, especially since joining the World Trade Organization (WTO). With the rapid development in terms of quantity, so far the system of CB has a network covering all provinces and cities in the country, particularly CBs has

Table 1. Problems of the bank system in Vietnam

The problems from the macro environment	The problems from commercial banks		The problems from management agencies
	Issues related to balance sheet assets	Issues related to operational efficiency and banking management	
<p>The effects of the global financial crisis 2008–2009.</p> <p>The situation of operation of enterprises that faced some difficulties.</p> <p>The confidence in the banking system decline.</p> <p>Request of banking services integration.</p>	<p>Tensions in liquidity.</p> <p>High credit growth.</p> <p>The credit structure is irrational.</p> <p>The proportion of deposits and loans to other CIs are large.</p> <p>The growth rate of capital sources does not keep up the growth rate of parties' use of resources.</p> <p>The imbalance in term between deposits and lending.</p> <p>NPL increased.</p> <p>Potential risks in CAR.</p> <p>The situation of cross-ownership (ability cope with risks of banks is not properly appreciated; cross-ownership could increase lending uncontrolled; The provisions on limits credit, loan classification and risk provisioning of SBV can be falsified by cross-ownership).</p> <p>Business operations focused on credits.</p>	<p>The results of business activity are low.</p> <p>Perform intermediary functions ineffective.</p> <p>Corporate governance is limited.</p> <p>The risk of system is high.</p>	<p>The operating monetary policy ineffective.</p> <p>Capacity inspection and supervision CBs of the SBV generally still limited.</p> <p>Market principles, discipline and safety in banking activities has not been think highly.</p>

Source: Compiled by author.

built their branches system covered until districts, even to the communes; the networks of the CB system spread across to different regions of the country, thereby increasingly satisfy the demand for banking services products by organizations and individuals in domestic and foreign, which contributed largely to economic development.

Besides, under pressure of increasing chartered capital to meet the requirements of competition and international economic integration, as well as reaching the requirements as stipulated in Decree No. 141/2006/ND-CP dated 22/11/2006 by the Government, by 2010, the minimum charter capital of the CB to reach is 3.000 billion VND. Up to now, the bank has fulfilled specified minimum legal capital, which some banks still have relatively high number of charter capital such as Vietcombank, BIDV, Vietinbank, Agribank, ACB... affiliates foreign banks also gradually increase the size of its charter

capital to ensure the operation of over 15 million USD.

The loans outstanding increased rapidly in recent years. In fact, the system of CB in Vietnam has played the dominant role of credit market (86,47% of the whole system), and this is a significant capital contribution for promoting economic growth of the country, as well as contributing to hunger eradication, poverty reduction and the stability and order of the society.

The foreign exchange management policy has been gradually liberalized. The implementation of the foreign exchange management policy has been conducted under the direction of decentralization, authorization management in order to improve accountability and efficiency of the local operations, while creating the conditions for business and people who implementation of the foreign exchange transactions, thereby helping CB have more conditional focus studying mechanisms and policies modeled modern Cen-

tral Bank. Besides, the Central Bank has removed more than one license in the appropriate direction gradually with international integration requirements, gradually meet the requirements of the administrative reform, creating a more open for economic exchange activities.

The system technology-banking sector has been a marked progress. This is shown very clearly that if, as before, in the payment process takes one day to a week to implement a completely payment transaction, now with the technological innovation, time for payments was reduced to only in minutes or even a second. Moreover, thanks to technological innovations that commercial banking system has given a lot of product value-added service platform based on the foundation of information technology, such as: ATM, POS, EFTPOS, EDC, internet banking, telephone banking, online banking... thereby contributing significantly to meet the needs of customers, as well as contributing to the production and development of cargo traffic.

Despite of the above results, the situation of operation of the CB in Vietnam these years still has problems:

The mobilization of the entire capital of the banking system continued to increase over the years, but the growth rate is not stable, which is a downward trend. In the early years of the global financial crisis, the growth rate of capital mobilization remained above 20%, but the next year deposit rate reached just over 12%. Some notable points in the mobilization of capital from 2008 to 2012: interest rate capital has complicated development; real interest rate exceeds

the interest rate prescribed; outstanding loans of the CB system increased sharply. In the period 2008–2012, the growth rate of outstanding loans is quite high, which is above 21,2%. Credit activities of the CB these years contained many hidden limitations: the ratio of granting credit compare with mobilization funds are far exceeded the permitted level of the Central Bank, which makes the liquidity system always tensions; hot credit growth leads to lower credit quality; loan term structure and term deposit unbalanced.

Credit activities of CB development towards to increase the scale and the speed of growth, but do not focus on improving credit quality in terms of macroeconomic instability, causing the quality of the very low credit that has become a bad debt. Non-performing loans (NPLs) of the CB system period 2008–2014 tended to increase.

This figure is the Central Bank announced, but according to the credit rating agency Fitch Ratings in 2011 was not be less than double digits to around 13%. NPL banks remained high and were a growing trend. Having too many banks is not bad, but the main problem is that banks do not operate effectively in such bad debt problems in the bank – the non-performing assets of the enterprise is the biggest challenge for the system of CB. The main bad debt situation of the banks worsened make requests bank restructuring could not delay further. Although we have established VAMC to handle bad loans, but until now, bad debt remains ‘ulcer’ of the CB.

Capital Adequacy Ratio (CAR) can reduce the loss if the CB reserve funds appropriated properly and fully in accordance with regulations of

Table 2. Transactions via ATM, POS/EFTPOS/EDC (in Quarter I/2015)

Terminal	Number of terminals	Number of transactions (item)	Value of transactions (VND billion)
ATM	16,112	162,009,637	378,868
POS/EFTPOS/EDC	192,255	11,772,833	44,613

Source: Payment and Settlement and Settlement Department – SBV.

Table 3. NPL of CBs system in period 2008–06/2015

Year	Unit: percentage (%)							
	2008	2009	2010	2011	2012	2013	2014	06/2015
NPLs	2.17	2.05	2.165	3.07	4.08	4.67	3.25	3.72

Source: Data compiled from the financial statements.

Table 4. Dealing with NPLs of Indonesia, South Korea, Malaysia and Thailand

	Indonesia	South Korea	Malaysia	Thailand
Centralized asset management corporation buys assets at subsidized prices	Yes	Assets were initially purchased above market-clearing prices with recourse. Since February 1998 purchases have been attempted at market prices	Purchased assets are valued by independent outside auditors.	Not applicable
Type of assets transferred	Worst assets	Not particular strategy	Loan larger than 5 million ringgit, and mostly loans secured by property or shares	Not applicable

Source: World Bank (2000).

Table 5. Key Statistical Ratios (as of 30/06/2015, growth rate as compared to the end of last year)

Unit: Billion VND, %

Categories of CIs	Total Assets		Regulatory capital		Charter Capital		ROA	ROE	CAR	Ratio of short-term funding to be used for medium-and long-term loans
	Amount	Growth rate	Amount	Growth rate	Amount	Growth rate				
State-owned banks	3,042,843	2.49	183,572	8.18	149,453	3.63	0.18	2.48	9.38	28.47
Joint stock commercial banks	2,675,509	-0.47	224,111	10.32	185,506	2.43	0.12	1.49	13.10	32.36
Joint venture, 100% foreign-owned banks, foreign banks' branches	724,017	3.14	113,395	7.58	89,455	3.27	0.16	0.97	34.37	-
Finance and leasing companies	76,227	11.00	16,353	7.53	18,749	-0.66	1.08	3.85	26.83	67.31
Cooperative bank and People's Credit Funds	95,311	9.44	3,061	21.94	5,483	13.49	0.70	5.20	30.97	43.30
Whole system	6,613,907	1.52	540,491	8.97	448,645	2.98	0.17	1.84	13.28	26.56

Source: State Bank of Vietnam (2015).

the SBV. Recently, as reported by CBs, a majority of CB has reached a rate guaranteed minimum equity capital of 8% recommended by Basel II. However, the rate of CAR also differs between banks and banking groups. Especially in the current period, the proportion of bad loans increased, while other revenues decreased, that of course this proportion will decline rapidly if

the CB compliance with the provisions of SB, accounting right, and enough provisions for debts.

The liquidity of the CB is sometimes precarious, in 2011, the proportion of capital in the banking system amounted to more than 100%, resulting in a lack of liquidity. This situation has improved, the percentage of capital ranged between 93–96%, but this is not for sure. For

world leading CBs, the rate of use of funds is only about 30–70%, and the rest of 30–40% will be used to invest in instruments with high liquidity, while the Vietnamese bank completely invested in credit. The liquidity of the CB is increasingly reflected declining proportion of total credits / total deposits increased continuously but mobilization in the expression decreased. So SBV issued Circular 13/2010/TT-NHNN, effective in October 2010 stipulated percentage at a maximum of 80% for banks and 85% for other credit institutions but so far the rate has not been reduced and the problem has not been solved. At the same time, the ratio of credit loans / deposits tends to increase, while higher credit growth in deposits growth. This is not a good thing to increase liquidity in the lending activities of banks.

The instability of macroeconomic in domestic particularly high inflation in the past year and the tight monetary policy of the Central Bank to curb inflation have put CB systems at the risk of high interest rate. In addition, the big and sudden fluctuations in interest rates, together with interest rate management measures are still heavily in administration which made the regular CB in coping state, likely this time will have the race of rising interest rates or we can have the lending rate maintained at very high levels to prevent fluctuations in interest rates in other time. Thus, the interest rate ceiling phenomenon occurs relatively commonly reduces the effectiveness of the monetary policy, simultaneously depress business ethics of many managers and optional staff in the system banking sector.

Governance capacity of the credit institution is inadequate compared to the scale, pace of credit growth and the level of risk. Capacity evaluation, appraisal, management and monitoring of credit using loans of CIs are still weak. A large part of credit funds and credit institutions invests in potential high-risk areas, such as property, therefore the fall in property prices will entail bad debts of the credit institutions increased.

Violation of legislation on credit-granting activities and secure banking operations resulted in many large bad debt credit institutions. Through the inspection, many credit institutions detected serious violations of safety regulations credit operations such as a limited

loan customers and people involved, especially the granting of loans great value for the largest shareholder and related persons. Borrowers with poor financial situation healthy or losses, dissolution, bankruptcy, using improper loans and investment plans, business inefficiency leads unable to repay bank loans. The legal system is still inadequate, especially in the field of land management, bankruptcy, dissolution of the business, civil enforcement, debt settlement, loan security assets remained problematic, complex, slowly overcome, finishing for creating facilitate for settlement of bad debts.

The disposal of bad loans depends on the macroeconomic conditions and the market, but the real estate market has been recovered, increasing difficulties in manufacturing business, slower consumer goods, low and slow improvements of businesses' financial capability and repayment capacity. The prolonged stagnation of the real estate market, the financial markets make it difficult to sell, handle property securing loans and bad debts have increased risk. Therefore, raising funds and seeking investors who have sufficient financial capacity to participate in the bad debts of the credit institution is not favorable.

In the economic transformation and emerging as Vietnam, the credit institution is still the main capital channel of the economy, so the evolution of macroeconomic indicators has profoundly affected the banking business activities and vice versa. Steaming from the practical at the end of 2011, the situation of Vietnam banking sector is potentially systemic risk, probably led to the factors that triggered the economic collapse: the lending rate increased to over 20% and lasted from 2009–2011; the liquidity of the CB system is in troubles, lending rates of Interbank up to 30–40%; NPLs increased rapidly; efficiency and profitability decline... imposes requirements on restructuring operations of the system.

With this situation, the restructuring of the banking system is seen as a key step in the strategic restructuring of the overall economy.

METHODS AND MODELS SPECIFICATION

This study analyses the effect of the restructuring banking system in Vietnam in the period

2008–2014 with 2 main methods: qualitative and quantitative.

In the qualitative method, the study analyses the indicators based on the criteria of the CAMEL (Capital adequacy, Assets quality, Management efficiency, Earnings performances, Liquidity) for 2 major banking groups in the banking system of Vietnam that are: (1) Group of 5 banks with the largest of total assets of Commercial Joint Stock Bank system of Vietnam and no acquisition or merger period from 2008 to 2014; (2) Group of banks trafficking, merged or restructured itself phase 2008–2014.

In the quantitative method, there are two ways to measure the efficiency of a bank: parametric (SFA, DFA, TFA) and non-parametric (DEA) approaches. However, this study will analyses the E-scores of 26 banks from Bank scope database source in the period 2008–2012 and examines the profits and productions efficiency of 7 DMUs in two years 2011, 2013 by using non-parametric approach, which is DEA model, to see the differences before and after the restructuring banking system in Vietnam. Additionally, this study will calculate the Z-scores and T-test by using SPSS program to assess the stability of Vietnam's banking system.

Due to the lack of data in 2015s, this study will only analyse the restructuring of banking system in Vietnam in the period from 2008 to 2014. The study will use a combination of methods analyse the assessment reports of the management agencies, the financial statements of banks to assess the status of restructuring the banking system in Vietnam. Data on Vietnamese CBs is collected from their audited annual reports, Bankscope, and the State Bank of Vietnam from 2008 to 2014. The secondary data was compiled from the reports of the Government and the Central Bank, the General Statistics Office, the Commercial banks with foreign specialized literature. The primary data was collected as follows: the topic will perform the survey of CB in Vietnam and divided into two groups, group banks undertook restructuring and group banks have not been restructured. This study also uses synthetic methods, analyses and compares some indicators of banking system before and after the restructuring process under the scheme "Restructuring the system of credit" approved in Decision 254/QĐ-CP.

In general, based on the practical usage of DEA application as above and the current situation of research into this field in Vietnamese banking sector, this paper will use two soft wares: DEA solver to analyses the efficiency of 26 banks by calculate the E-score and Z-score; MaxDEA 2.1 to analyses the profit efficiency and production efficiency before and after the restructuring of the banking system of 7 banks.

The data in this study, which were obtained from the Vietnamese Banking Statistics, consists of annual observations of outputs and inputs from 28 sample commercial banks in Vietnam in period 2008–2012. Because of the lack of data of 28 sample banks from 2013 to 2015, therefore this study only focuses on the period 2008–2012.

In this study, the inputs and outputs variables of both soft wares DEA solver and MaxDEA 2.1 will be chosen regarding their important to the banking activities. For the software MaxDEA 2.1, this study calculate the profit efficiency and production efficiency of 7 banks then drawn to comment on the initial results of the process of restructuring at the bank.

The names and the result of the sample banks are provided in Appendix 2, 3 4 and 5.

DATA ENVELOPMENT ANALYSIS (DEA) MODEL

The financial system, especially the banking system in Vietnam, is potentially risky. The implementation of effective assessment and financial supervision are primarily oriented towards compliance analysis, control risks, models of credit risk ratings are less studied and applied. Among a variety of methodologies, the model DEA is widely used to evaluate efficiency performance of the banking sector.

Data Envelopment Analysis (DEA) was first introduced by Charnes et al (1978), and has now been widely used in performance evaluation or productivity evaluation. DEA is one way of testing for X-efficiencies. DEA is a "non-parametric" approach because it is not based on any explicit model of the frontier. The methodology was originally developed for non-profit-making organizations, because accounting profit measures are difficult to compute. The purpose of DEA is to construct a nonparametric envelopment frontier over the data points such that all

Table 6. The variables of 2 soft wares

Variables	DEA solver		MaxDEA 2.1	
	3 inputs – 3 outputs	3 inputs – 5 outputs	Profits efficiency	Productions efficiency
Inputs	(X1) fixed assets (X2) deposits (X3) operating expenses	(X1) fixed assets (X2) deposits (X3) operating expenses	(X1) cost of borrowing (X2) operating costs	(X1) payments to employees (X2) payments to suppliers
Outputs	(Q1) total loans. (Q2) securities (Q3) operating income	(Q1) total loans. (Q2) securities. (Q3) operating income (Q4) ROAA (Q5) ROAE	(Q1) interest income. (Q2) income from operations.	(Q1) client's deposits (Q2) customer lending

Source: Compiled by author.

Note: (Q2) are estimated by the investment securities includes investment securities available for sale, investment securities held to maturity – diminution in value of investment securities.

observed points lie on or below the production frontier. DEA compares the observed outputs (Y_{jp}) and inputs (X_{jp}) of several organizations. If measuring cost X-efficiency, the relatively more efficient firms can be compared against the relatively less efficient by identifying a “best practice” firm or firms. To do this, maximize the following:

$$E_p = \sum u_j Y_{jp} / \sum v_i X_{ip}$$

Subject to $E_p \leq 1$ for all p ; where p represents several organizations and weights $v_i, u_j > 0$. A linear programming model is run respectively with each firm appearing in the objective function once to derive individual efficiency ratings. Each firm will have a derived rating of E, a measure of relative efficiency. Efficiency is defined and measured as the distance from a best practice frontier. The closer E is to 1, the higher the relative efficiency. E = 1 is for the “best practice” unit, and will be lower for all other firms in the study. Thus, $E < 1$, which implies relative inefficiency. The DEA efficiency score for a specific firm (DMUs) is not defined by an absolute standard but it is defined relative to the other firms in that particular data set. In this study, we chose 7 sample banks before restructuring or self-restructuring (in 2011) and after the implementation of restructuring (in 2013) by running in MaxDEA 2.1 software (see the name of sample banks in appendix 3).

THE Z-SCORE

The Z-index is an inverse proxy for the firm’s probability of failure. It combines profitability, leverage, and return volatility in a single measure. It is given by the ratio:

$$Z_i = \frac{ROA_i + E / TA_i}{\sigma ROA_i}$$

where ROA_i is the period-average return on assets for bank i , E/TA represents the period-average equity to total assets ratio for bank i , and σROA_i is the standard deviation of return on assets over the period under study, which is 2011 and 2013. The Z-index increases with higher profitability and capitalization levels, and decreases with unstable earnings reflected by a higher standard deviation of return on assets. It inversely proxies the bank’s probability of failure and is an indicator of financial stability at the firm level.

EMPIRICAL RESULTS

Quantitative analysis of the results of restructuring

The result of the Efficiency of 26 banks through E-scores in the period 2008–2012 together with the result of the profit efficiency and production efficiency of 7 banks in 2 years, 2011 and 2013.

The result of the E-scores including compare between listed banks and unlisted banks.

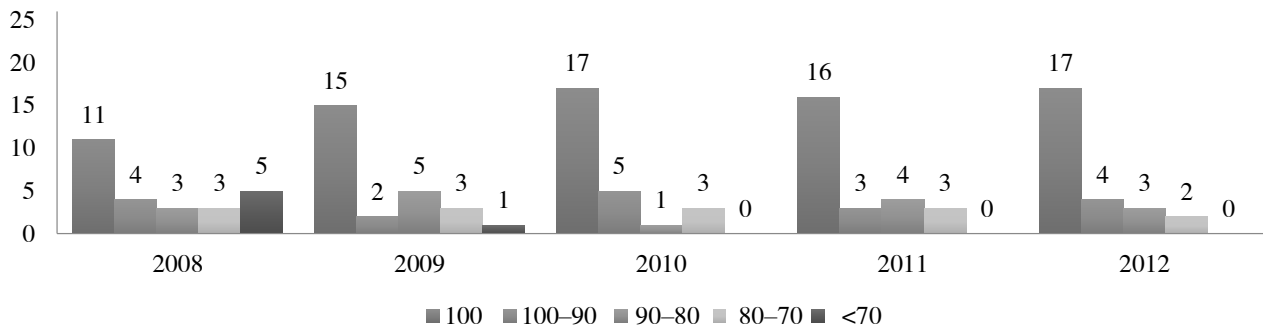


Figure 1. The E-scores of 26 banks in case 3 inputs – 3 outputs in period 2008–2012

Source: Author's calculation.

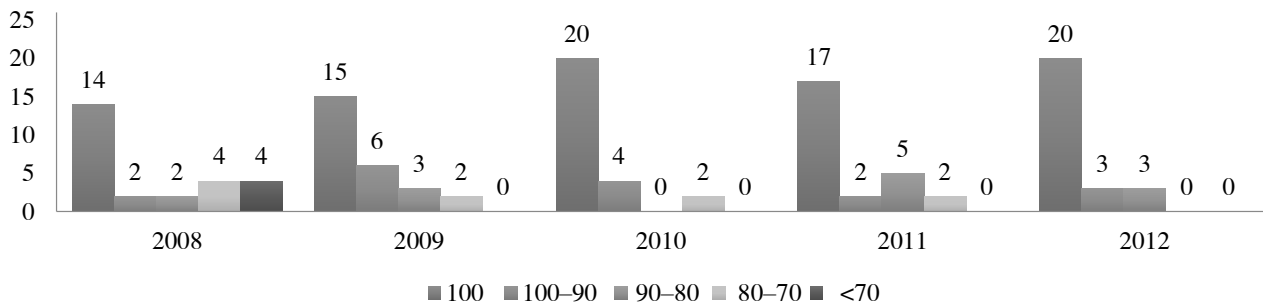


Figure 2. The E-scores of 26 banks in case 3 inputs – 5 outputs in period 2008–2012

Source: Author's calculation.

Table 8. Listed banks versus Unlisted banks in case 3 inputs – 5 outputs in period 2008–2012

Efficiency (%)	2008		2009		2010		2011		2012	
	L	U	L	U	L	U	L	U	L	U
100	3	11	3	12	6	14	4	13	6	14
90-100	1	1	3	3	2	2	1	1	0	3
80-90	1	1	1	2	0	0	2	3	2	1
70-80	1	3	1	1	0	2	1	1	0	0
<70	1	3	0	0	0	0	0	0	0	0

Source: Author's calculation.

The result of the Profit efficiency

Table 9. The results of DEA model to assess the effectiveness of the bank's profits before and after restructuring

No.	Name of bank	2011	2013
1	Ho Chi Minh City Development Joint Stock Commercial Bank	1.00000	0.93978
2	Lien Viet Post Joint Stock Commercial Bank	1.00000	1.00000
3	National Citizen Commercial Joint Stock Bank	0.95397	0.81332
4	Vietnam Public Joint Stock Commercial Bank	0.67122	n.a
5	Saigon-Hanoi Commercial Joint Stock Bank	0.93006	0.95855
6	Tien Phong Commercial Joint Stock Bank	0.63192	0.99266
7	Vietnam Bank for Industry and Trade	1.00000	1.00000

Source: Author's calculation.

The result of the Production efficiency

Table 10. The results of DEA model to assess the effectiveness of the bank's productions before and after restructuring

No.	Name of bank	2011	2013
1	Ho Chi Minh City Development Joint Stock Commercial Bank	0.61362	1.00000
2	Lien Viet Post Joint Stock Commercial Bank	0.62392	0.75447
3	National Citizen Commercial Joint Stock Bank	1.00000	0.46902
4	Vietnam Public Joint Stock Commercial Bank	1.00000	n.a
5	Saigon-Hanoi Commercial Joint Stock Bank	0.57565	1.00000
6	Tien Phong Commercial Joint Stock Bank	0.18166	0.65768
7	Vietnam Bank for Industry and Trade	0.68691	0.84887

Source: Author's calculation.

The result of the Stability of 26 banks through Z-scores and T-test

Table 11. Results of Z-scores and T-test of SPSS program

Method	df	Value	Probability
t-test	49	2.060769	0.0447
Satterthwaite-Welch t-test*	30.17423	2.029611	0.0513
Anova F-test	(1, 49)	4.246770	0.0447
Welch F-test*	(1, 30.1742)	4.119319	0.0513
*Test allows for unequal cell variances			
Analysis of Variance			
Source of Variation	df	Sum of Sq.	Mean Sq.
Between	1	2123.637	2123.637

Table 11

Method		df	Value	Probability
Within		49	24502.90	500.0593
Total		50	26626.54	532.5308
Category Statistics				
Variable	Count	Mean	Std. Dev.	Std. Err. of Mean
Z_CORE_2013	25	25.19819	29.90968	5.981937
Z_SCORE_2011	26	12.28991	11.01411	2.160044
All	51	18.61750	23.07663	3.231374

Source: Author's calculation.

With $p = 0.0447 < 0.05$, there is a significant difference of two overall average.

Qualitative analysis of the results of restructuring

In this section, the study analyses the indicators based on the criteria of the CAMEL (Capital adequacy, Assets quality, Management efficiency, Earnings performances, Liquidity) for each group in the banking system of Vietnam. In CAMEL criteria, the indicators were selected as follows:

Table 12. Assessment framework CAMEL

Indicators	Contents
C (Capital adequacy)	Capital structure, focusing on the level of relative importance of tier 1,2 capital Coefficient of capital adequacy ratio CAR
A (Assets quality)	NPLs ratio / Total loans
M (Management efficiency)	Expenditure / Income
E (Earnings performances)	ROA ROE NII
L (Liquidity)	The proportion of assets with high liquidity / total deposits

The study evaluated 2 major banking groups: (1) Group of 5 banks with the largest of total assets of Commercial Joint Stock Bank system of Vietnam and no acquisition or merger period from 2008 to 2014; (2) Group of banks trafficking, merged or restructured itself phase 2008–2014.

Group 5 commercial banks largest joint stock (by total assets)

Research data collected five commercial banks which are not traded or merged in the period from 2008 to 2014 and are in the top of the bank had total assets of the largest were: Vietnam Joint Stock Commercial Bank for Industry and Trade (Vietinbank), Bank for Investment and Development of Vietnam (BIDV), Joint Stock Commercial Bank for Foreign Trade of Vietnam (Vietcombank), Military Commercial Joint Stock (MB Bank) and Asian Commercial Joint Stock Bank (ACB). The percentage of holding deposits of these five commercial banks compare to the total deposits of this entire system of commercial banks is as follows:

Table 13. The proportion of deposits held by 5 largest banks compared with the total deposits of commercial banks system phase 2008–2014

Unit: percentage (%)

Year	2008	2009	2010	2011	2012	2013	2014
%Total deposits of 5 largest commercial banks / Total deposits of all banks	46.06	42.84	42.64	43.96	40.82	40.13	40.03

Source: Data compiled from the financial statements.

Table 14. The average CAR of group 5 largest commercial banks (by total assets) in the period 2009–2014

Unit: percentage (%)

Year	2009	2010	2011	2012	2013	2014
CAR	9.94	9.91	12.74	11.29	11.73	11.42

Source: Data compiled from the financial statements.

Table 15. The average of NPL ratio of group 5 largest commercial banks (by total assets) in the period 2008–2014

Unit: percentage (%)

Year	2008	2009	2010	2011	2012	2013	2014
NPLs	2.54	1.79	1.71	1.75	2.05	2.18	2.05

Source: Data compiled from the financial statements.

Table 16. The average ratio of expenditure / income of group 5 largest commercial banks (by total assets) in the period 2008–2014

Unit: percentage (%)

Year	2008	2009	2010	2011	2012	2013	2014
Expenditure / Income	40	41.7	41.3	41.4	45.9	45.4	45.1

Source: Data compiled from the financial statements.

Table 17. The average coefficient of ROA, ROE and NII of group 5 largest commercial banks (by total assets) in the period 2008–2014

Unit: Billion VND, %

Year	2008	2009	2010	2011	2012	2013	2014
ROA	0.0131	0.0129	0.0121	0.0119	0.0094	0.0089	0.0098
ROE	0.1842	0.1952	0.1897	0.1972	0.1307	0.1104	0.1237
NII	4,839.63	5,209.57	7,431.73	11,387.73	11,208.27	10,704.11	11,552.42

Source: Data compiled from the financial statements.

Table 18. The average of liquidity index of group 5 largest commercial banks (by total assets) in the period 2008–2014

Unit: percentage (%)

Year	2008	2009	2010	2011	2012	2013	2014
Assets have high liquidity / Total deposits	5	3.6	4.3	3.1	2.7	2.1	1.7

Source: Data compiled from the financial statements.

The group of commercial banks make purchases, mergers and restructuring itself phase 2008–2014

In the period 2008–2014, commercial banks have been staking weakness and in turn conducted the acquisitions, mergers or approved by the State Bank to restructure itself. In this section, this study analyses the indicators CAMEL of group banks traded, merged or restructured itself as follows: Ho Chi Minh City Development Joint Stock Commercial Bank (HD Bank), Lien Viet Post Joint Stock Commercial Bank (LienvietpostBank), National Citizen Commercial Joint Stock Bank (NVB), Ocean Commercial Joint Stock Bank (Ocean Bank), Saigon – Hanoi Commercial Joint Stock Bank (SHB Bank), Tien Phong Commercial Joint Stock Bank (TP Bank), Vietnam Joint-Stock Commercial Bank for Industry and Trade (Vietinbank) and Vietnam Public Joint Stock Commercial Bank (PVcomBank).

Table 19. The average CAR of group 7 banks in restructured from 2009 to 2014

Unit: percentage (%)

Year	2009	2010	2011	2012	2013	2014
CAR	14.2	12.7	17.9	19.5	14.0	16.2

Source: Data compiled from the financial statements.

Table 20. The average of NPL ratio of group 7 banks in restructured from 2008 to 2014

Unit: percentage (%)

Year	2008	2009	2010	2011	2012	2013	2014
NPLs	1.63	1.54	3.04	2.34	4.67	3.48	3.05

Source: Data compiled from the financial statements.

Table 21. The average ratio of expenditure / income of group 7 banks in restructured from 2008 to 2014

Unit: percentage (%)

Year	2008	2009	2010	2011	2012	2013	2014
Expenditure / Income	45.10	37.61	45.4	76.29	107.83	69.23	53.43

Source: Data compiled from the financial statements.

Table 22. The average coefficient of ROA, ROE and NII of group 7 banks in restructured from 2008 to 2014

Unit: Billion VND, %

Year	2008	2009	2010	2011	2012	2013	2014
ROA	0.0168	0.0124	0.0092	0.0072	0.0029	0.0040	0.0058
ROE	0.0740	0.1054	0.0935	0.0740	0.0277	0.0425	0.0584
NII	379.90	412.97	610.21	990.14	1,155.51	1,310.03	1,458.90

Source: Data compiled from the financial statements.

Table 23. The average of liquidity index of group 7 banks in restructured from 2008 to 2014

Unit: percentage (%)

Year	2008	2009	2010	2011	2012	2013	2014
Assets have high liquidity / Total deposits	10.5	5.3	4.9	3.1	2.3	1.4	1.2

Source: Data compiled from the financial statements.

In summary, since 2010 until now, the activities of restructuring in the group of commercial banks have resulted in positive changes, such as reduced bad debt ratio, effective management and results of operations was initially improving. Meanwhile, banks still need a lot of effort to maintain capital adequacy ratio and bring liquidity to a higher level.

From the two banking groups under study: group of five banks had the largest of total assets and experienced no acquisition, merger or restructuring itself; and a group of seven banks trafficking, merged or restricted itself phase from 2008 to 2014, the results show that the process of restructuring the banking system have different impacts to different bank groups. Specifically, the process of restructuring has no clear impact on banks with large scale dominate the market and not be restricted, while the bank has undergone the direct restructuring, it obtains the positive results in 2014.

CONCLUSION

The process of restructuring the banking system in the period 2008–2014 is still restricted due to the following main reasons:

Firstly, the process of restructuring the banking system is not synchronization with the restructuring of public investment and restructuring of state-owned enterprises (SOEs).

Three key tasks have been identified in close relationship with each other in the economic restructuring of Vietnam in the period 2011–2015 are: (1) restructuring the banking system, (2) restructuring of public investment and (3) the restructuring of SOEs. However, due to the period 2008–2014, the process of restructuring the banking system has no coherence and coordination with the two remaining tasks. The restructuring of SOEs through privatization and divestment in the SOEs State not required holding shares of the State utmost delays while the most bad debts of the banking system came from SOEs with relationships to the bank.

Secondly, the objectives and priorities for restructuring established inappropriate.

The scheme 254 set too many tasks and measures to restructure the CIs for 2011–2015 as well as for each year. The scheme restructuring process focused on implementing priority handling

weak CIs through M&A in the absence of mechanisms for handling resolutely and radically bad debts and problems of cross-ownership as well as issues governance in CIs led to the restructuring results not as expected and the system does not guarantee the sustainable development of CIs.

Thirdly, the lack of legal framework for the restructuring of the banking system.

The legal framework relating to the main aspects of the restructuring of CIs such as bad debts, M&A of CIs, risk management of CIs, cross-ownership of CIs, State capital management and State divestments problems at CIs, intervention of the State of the weak CIs, bankruptcy of the CIs... are missing and asynchronous. In the process of restructuring since 2008 until now, the Central Bank has issued a number of documents complete the legal framework for banking system administrators but patchwork and asynchronous. Restrictions on institutional and legal framework has made the process of restructuring in the period 2008–2014 were difficult as: the bad debts of the CIs fell into a stalemate, the M&A of weak CIs is not achieving its objectives, not handle cross-ownership status in the CIs.

Finally, the lack of political and the coordination have not synchronized by the State management agencies in restructuring.

Before the scheme 254 by Vietnam Prime Minister issued in 03/01/2012, there were a lot of comments that in order to have an effective process of restructuring, there must be the political determination in performing restructure through the establishment of an inter-agency committee or committee bank restructuring by one of the Prime Minister or Deputy Prime Minister headed. The experience of restructuring of the country shown that these recommendations are science-based and practical. For example, research by Dziobek and Pazarbaşıoglu (1997) by examining the policy of restructuring the banking system of 24 countries on 6 territories showed that only 20% of the country with high efficiency in the restructuring the banking system with the Central Bank implemented the restructuring process and with the country effectively lower, this figure is up to 100%.

However, the final scheme 254 was adopted in the form decision of the Prime Minister and the permanent body implementing the scheme is the State Bank of Vietnam. The allocation for the permanent Central Bank implemented the scheme in terms of the role and independent status of the Central Bank in managing monetary policy is rather limited as well as the scheme has relationships with several other Ministries such as the issue of restructuring of the SOEs of the Ministry of Finance, the issue of public investment restructuring of the Ministry of Planning and investment and other line ministries have made effective implementation of the scheme in 2008–2014 not as high as the period expectations and objectives of the scheme. Before asynchronous collaboration between the State authorities, after nearly 3 years of implementation of the scheme, on 11/03/2014, on the basis of the Report of the Central Bank, the Prime Minister issued Decision No.363/QD-TTg on the establishment of inter-agency steering committee whether later but is expected to help accelerate the process of restructuring the CIs system in the future.

To summarize, restructuring the banking system as a means of bringing the macro level, with enormous influence on the economy of the country. Before this process takes place, governments will have to devise a specific implementation roadmap for gradually removing internal

difficulties. Directly, process reengineering commercial banking system would obviously solve the factors which negatively affect banks, to help the banking system becomes healthy, effective and energy greater competitiveness. Indirectly, it is helping the economy to grow, create a favorable environment for business activity and expansion. Before achieving the final goal, the process of restructuring the commercial banking system will create short-term goals and long-term objectives consistent roadmap outlined. In short, the Government, the Central Bank will solve the immediate difficulties, the cause of this process such as stable interest rates and exchange rate policy with the resolutions and the instruments on hand. Maybe these measures are not comprehensive but in the current situation will help stabilize banks temporary basis for sustainable development at a later stage. The success of banks restructuring depends, ultimately, on a favourable macroeconomic environment and the wherewithal of the authorities to make hard (often political unpopular) decisions regarding banking system restructuring. Last but not least, future research on cross – sectional expect such as comparing with foreign banks and branches in Vietnam, or with foreign banks in other countries in the region, or compare with the efficiency in other industries within the country... will then still are very important.

APPENDICES

Appendix 1. The system of CIs in Vietnam

State-owned commercial banks	Vietnam Bank for Agriculture and Rural Development (Agribank); Ocean Commercial One Member Limited Liability Bank; Construction Commercial One Member Limited Liability Bank.
Wholly foreign owned banks	ANZ Bank (Vietnam) Limited; Hong Leong Bank Vietnam Limited; Hongkong – Shanghai Bank Vietnam Limited; Shinhan Bank Vietnam Limited; Standard Chartered Bank (Vietnam) Limited.
Joint-ventures banks	Indovina Bank Limited; VID Public Bank; Vietnam – Russia Joint Venture Bank; Vinasiam Bank
Commercial banks	Asian Commercial Bank (ACB); Tien Phong Bank (TP Bank); DongA Bank (DAB); SeABank; ABBank; BacABank (NASB); Viet Capital Bank (VCCB); Maritime Bank (MSB); Techcombank; KienLongBank; Nam A Bank; National Citizen Bank (NVB); VPBank; HDBank; Orient Commercial Bank (OCB); Military Bank (MBB); PVcom Bank; VIBBank (VIB); Sai Gon (SCB); Saigonbank (SHB); SHBank (SHB); Sacombank (STB); VietABank (VAB); BaoVietBank (BVB); VietBank; Petrolimex Group Bank (PG Bank); Eximbank (EIB); LienVietPostBank (LPB); Ngoai Thuong Viet Nam (VCB); Vietinbank (CTG); BIDV; Agribank
Policies banks	Vietnam Bank for Social Policies (VBSP); Vietnam Development Bank (VDB)
Cooperative bank	Central People's Credit Fund

Source: State Bank of Vietnam, 2015.

Appendix 2. Efficiency (Score) summary of research sample by DEA solver with 3 inputs and 3 outputs

No.	Bank	Code	2008	2009	2010	2011	2012
1	Saigon Thuong Tin Commercial Joint Stock Bank	STB	0.7491	0.8937	0.9142	0.8511	0.8173
2	Asia Commercial Bank	ACB	1.0000	1.0000	1.0000	0.9806	0.8548
3	Petro Vietnam Finance Joint Stock Corporation	PVF	1.0000	1.0000	1.0000	1.0000	1.0000
4	Saigon-Hanoi Commercial Joint Stock Bank	SHB	0.8053	0.7679	0.7576	0.7692	0.7336
5	Bank for Foreign Trade of Vietnam	VCB	1.0000	1.0000	1.0000	1.0000	1.0000
6	Vietnam Joint Stock Commercial Bank for Industry and Trade	CTG	1.0000	1.0000	1.0000	1.0000	1.0000
7	Vietnam Export Import Commercial Joint Stock Bank	EIB	0.9305	0.8850	1.0000	1.0000	0.9755
8	Vietnam Technological and Commercial Joint Stock Bank	TCB	1.0000	1.0000	1.0000	1.0000	1.0000
9	Lien Viet Post Joint Stock Commercial Bank	LVB	1.0000	1.0000	1.0000	1.0000	0.9839
10	Housing Development Commercial Joint Stock Bank City, Ho Chi Minh	HDB	0.7744	0.8438	0.9321	0.8542	0.9729
11	Orient Commercial Stock Bank	OCB	0.6948	0.8508	0.9680	0.9666	1.0000
12	Saigon Bank for Industry and Trade	SGB	0.9025	0.7448	1.0000	1.0000	1.0000
13	An Binh Commercial Joint Stock Bank	ABB	0.5027	0.6619	0.7399	0.8131	0.7887
14	Southern Commercial Joint Stock Bank	PNB	0.6237	1.0000	1.0000	1.0000	1.0000
15	National Citizen Commercial Joint Stock Bank	NVB	0.7793	1.0000	1.0000	1.0000	1.0000
16	Nam A Commercial Joint Stock Bank	NAB	0.5816	0.7823	0.9143	0.9367	1.0000
17	Viet Capital Commercial Joint Stock Bank	GDB	1.0000	1.0000	1.0000	1.0000	1.0000
18	Vietnam Prosperity joint Stock Commercial Bank	VPB	0.6473	0.8052	1.0000	1.0000	1.0000
19	Ocean Commercial Joint Stock Bank	DCB	1.0000	1.0000	1.0000	1.0000	1.0000
20	Military Commercial Joint Stock Bank	MBB	0.9432	0.9842	0.9896	0.7658	1.0000
21	Maritime Commercial Joint Stock Bank	MSB	0.8953	1.0000	1.0000	1.0000	1.0000
22	Vietnam International Commercial Joint Stock Bank	VIB	0.8443	1.0000	1.0000	1.0000	1.0000

No.	Bank	Code	2008	2009	2010	2011	2012
23	Bank for Investment and Development of Vietnam	BIDV	1.0000	1.0000	1.0000	1.0000	1.0000
24	Petrolimex Group Commercial Joint Stock Bank	PGB	1.0000	1.0000	1.0000	1.0000	1.0000
25	Mekong Housing Bank	MHB	1.0000	1.0000	0.7603	0.7046	0.9027
26	Eastern Asia Commercial Bank	EAB	0.9081	0.9264	0.8388	0.8378	0.8509

Source: Author's calculation

Appendix 3. Efficiency (Score) summary of research sample by DEA solver with 3 inputs and 5 outputs

No.	Bank	Code	2008	2009	2010	2011	2012
1	Saigon Thuong Tin Commercial Joint Stock Bank	STB	0.7783	0.9772	0.9469	0.8511	0.8173
2	Asia Commercial Bank	ACB	1.0000	1.0000	1.0000	1.0000	0.8548
3	Petro Vietnam Finance Joint Stock Corporation	PVF	1.0000	1.0000	1.0000	1.0000	1.0000
4	Saigon-Hanoi Commercial Joint Stock Bank	SHB	0.8096	0.8036	0.9293	0.8203	1.0000
5	Bank for Foreign Trade of Vietnam	VCB	1.0000	1.0000	1.0000	1.0000	1.0000
6	Vietnam Joint Stock Commercial Bank for Industry and Trade	CTG	1.0000	1.0000	1.0000	1.0000	1.0000
7	Vietnam Export Import Commercial Joint Stock Bank	EIB	0.9305	0.9442	1.0000	1.0000	1.0000
8	Vietnam Technological and Commercial Joint Stock Bank	TCB	1.0000	1.0000	1.0000	1.0000	1.0000
9	Lien Viet Post Joint Stock Commercial Bank	LVB	1.0000	1.0000	1.0000	1.0000	1.0000
10	Housing Development Commercial Joint Stock Bank City, Ho Chi Minh	HDB	0.7744	0.8438	0.9321	0.8542	0.9768
11	Orient Commercial Stock Bank	OCB	0.7437	0.9495	1.0000	0.9666	1.0000
12	Saigon Bank for Industry and Trade	SGB	1.0000	0.9143	1.0000	1.0000	1.0000
13	An Binh Commercial Joint Stock Bank	ABB	0.5027	0.7014	0.7727	0.8131	0.8448
14	Southern Commercial Joint Stock Bank	PNB	0.6836	1.0000	1.0000	1.0000	1.0000
15	National Citizen Commercial Joint Stock Bank	NVB	0.7793	1.0000	1.0000	1.0000	1.0000
16	Nam A Commercial Joint Stock Bank	NAB	0.5816	0.7823	1.0000	0.9367	1.0000
17	Viet Capital Commercial Joint Stock Bank	GDB	1.0000	1.0000	1.0000	1.0000	1.0000
18	Vietnam Prosperity joint Stock Commercial Bank	VPB	0.6616	0.8128	1.0000	1.0000	1.0000

No.	Bank	Code	2008	2009	2010	2011	2012
19	Ocean Commercial Joint Stock Bank	DCB	1.0000	1.0000	1.0000	1.0000	1.0000
20	Military Commercial Joint Stock Bank	MBB	0.9934	0.9918	1.0000	0.7881	1.0000
21	Maritime Commercial Joint Stock Bank	MSB	1.0000	1.0000	1.0000	1.0000	1.0000
22	Vietnam International Commercial Joint Stock Bank	VIB	0.8443	1.0000	1.0000	1.0000	1.0000
23	Bank for Investment and Development of Vietnam	BIDV	1.0000	1.0000	1.0000	1.0000	1.0000
24	Petrolimex Group Commercial Joint Stock Bank	PGB	1.0000	1.0000	1.0000	1.0000	1.0000
25	Mekong Housing Bank	MHB	1.0000	1.0000	0.7603	0.7046	0.9027
26	Eastern Asia Commercial Bank	EAB	1.0000	0.9606	0.9677	0.8946	0.9508

Source: Author's calculation.

Appendix 4. The commercial affairs about M&A of banks in Vietnam in the period of restructuring the banking system

Year	The organizations before M&A	The organizations after M&A	The form of M&A	The implementation
2011	Sai Gon Commercial Bank (SCB) Vietnam Tin Nghia Commercial Joint Stock Bank (Vietnam Tin Nghia Bank) First Joint Stock Bank (FICOMBANK)	Sai Gon Joint Stock Commercial Bank	Consolidated	Completed
2012	Hanoi Building Commercial Joint Stock Bank (HabuBank) Sai Gon-Ha Noi Commercial Joint Stock Bank (SHB)	Sai Gon-Ha Noi Commercial Joint Stock Bank (SHB)	Merger	Completed
2013	DaiA Bank Ho Chi Minh City Development Joint Stock Commercial Bank (HDBank)	Ho Chi Minh City Development Joint Stock Commercial Bank (HDBank)	Merger	Completed
2013	WesternBank PetroVietnam Finance Corporation (PVFC)	Vietnam Public Joint Stock Commercial Bank (PVcombank)	Consolidated	Completed
2015	Housing Bank of Mekong (MHB) Joint Stock Commercial Bank for Investment and Development of Vietnam (BIDV)	Joint Stock Commercial Bank for Investment and Development of Vietnam (BIDV)	Merger	Completed
2015	Petrolimex Group Commercial Joint Stock Bank Vietnam Bank for Industry and Trade (Vietinbank)	Vietnam Bank for Industry and Trade (Vietinbank)	Merger	Completed
2015	Southern Commercial Joint Stock Bank Saigon Thuong Tin Commercial Joint Stock Bank	Saigon Thuong Tin Commercial Joint Stock Bank	Merger	SBV has approved undertakings

Year	The organizations before M&A	The organizations after M&A	The form of M&A	The implementation
2015	Mekong Development Commercial Joint Stock Bank (MDBank) Vietnam Maritime Commercial Stock Bank	Vietnam Maritime Commercial Stock Bank	Merger	SBV has approved undertakings
2015	An Binh Commercial Joint Stock Bank DongA Bank	DongA Bank	Consolidated / Merger	SBV has approved undertakings

Source: Compiled by author.

Appendix 5. M&A among banks and financial companies in Vietnam

Year	The commercial affairs M&A	The implementation
2013	WesternBank consolidated with PetroVietnam Finance Corporation (PVFC)	Completed
2013	Ho Chi Minh City Development Joint Stock Commercial Bank acquires SGVF	Completed
2014	VPBank acquires Vinacomin	Completed
2015	Vinaconex-Viettal Finance Joint Stock Company merged Saigon-Hanoi	SBV has approved undertakings
2015	Vietnam Maritime Commercial Stock Bank acquires TFC	SBV has approved undertakings
2015	Techcombank acquires Vietnam Finance Joint Stock Company	SBV has approved undertakings
2015	Military Commercial Joint Stock Bank (MB Bank) participate restructuring Song Da Finance Joint Stock Company (SDFC)	SBV has approved undertakings
2015	Joint Stock Commercial Bank for Investment and Development of Vietnam (BIDV) acquires Post and Telecommunication Finance company limited (FPT) towards acquisition / merger	SBV has approved undertakings

Source: Compiled by author.

Appendix 6. List of listed and unlisted banks

	Listed	Unlisted
Number of banks	8	18
Name of banks	Saigon Thuong Tin Commercial Joint Stock Bank; Asia Commercial Bank; Saigon-Hanoi Commercial Joint Stock Bank; Bank for Foreign Trade of Vietnam; Vietnam Joint Stock Commercial Bank for Industry and Trade; Vietnam Export Import Commercial Joint Stock Bank; National Citizen Commercial Joint Stock Bank; Military Commercial Joint Stock Bank.	Vietnam Technological and Commercial Joint Stock Bank; Lien Viet Post Joint Stock Commercial Bank; Ho Chi Minh City Development Joint Stock Commercial Bank; Orient Commercial Stock Bank; Saigon Bank for Industry and Trade; An Binh Commercial Joint Stock Bank; Southern Commercial Joint Stock Bank; Nam A Commercial Joint Stock Bank; Viet Capital Commercial Joint Stock Bank; Vietnam Prosperity joint Stock Commercial Bank; Ocean Commercial Joint Stock Bank; Maritime Commercial Joint Stock Bank; Vietnam International Commercial Joint Stock Bank; Bank for Investment and Development of Vietnam; Petrolimex Group Commercial Joint Stock Bank; Mekong Housing Bank; Eastern Asia Commercial Bank

Source: State Bank of Vietnam, 2015.

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