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Income Diversification and Bank Efficiency in Vietnam

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Abstract

This study uses the DEA (Data Envelopment Analysis) method to estimate the technical efficiency index of 34 Vietnamese commercial banks in the period 2007-2015, and then it analyzes the impact of income diversification on the operational efficiency of Vietnamese commercial banks through a censored regression model - the Tobit regression model. Research results indicate that income diversification has positive effects on the operational efficiency of Vietnamese commercial banks in the research period. Based on study results, in this research some recommendations forpolicy are given to enhance the operational efficiency of Vietnam's commercial banking system.

Keywords: Bank efficiency; commercial bank; income diversification.

1. Introduction

Mercieca, Schaeck and Wolfe (2007) proposed that diversification in the banking sector was done in three dimensions: (i) Product lines and services diversification; (ii) Diversification of geographical location, and (iii) Diversification thanks to a combination of product lines, services, and geographical location. Income diversification of commercial banks was associated with the diversification of business activities and the gradual reduction of the income proportion from traditional credit operations. According to the Modern Portfolio Theory (MPT) of Markowitz in 1952, portfolio diversification would help investors or banks minimize risks or maximize profits in the same portfolio risk case.

The current studies in the world on the effect of income diversification on the performance of commercial banks also led to different conclusions that income diversification played an important role in bank efficiency. The research by Chronopoulos et al. (2011), Lee et al. (2014) supported the view point that income diversification would help banks increase efficiency. Whereas the studies of Vennet (2002), Stiroh and Rumble (2006), Elyasiani and Wang (2012) and a series of other studies indicated that income diversification or bank activities had an inverse relationship with operational efficiency and even increased risks for banks.

Current studies in Vietnam have focused on analyzing the effects of income diversification on the profitability of commercial banks. The research by Ho Thi Hong Minh and Nguyen Thi Canh (2015) studied the relationship between income diversification and the profitability of 22 Vietnam commercial banks in the period 2007-2013 according to SGMM. The result indicated that income diversification had a positive effect on the profitability of Vietnamese commercial banks.

Lam Chi Dung et al. (2015) analyzed the impact of income from non-credit activities on the profitability of 17 commercial banks in Vietnam over the period 2002 – 2013. The result showed that increasing the rate of turnover from non-credit activities had a positive effect on the profitability of commercial banks in Vietnam.

Le Xuan Quynh and Pham Long Hau (2016) used data of 26 commercial banks for the period 2006 - 2014 to analyze the relationship between income diversification and the business efficiency of Vietnamese commercial banks. The result of the study showed that a positive relationship or income diversification had positive effects on the commercial banks' business efficiency in the study period.

However, there are not any studies, which have analyzed the impact of income diversification on the operational efficiency of commercial banks in Vietnam until the present time. Therefore, this research is done in the hope of analyzing the impact of income diversification on the operational efficiency through technical efficiency indexesof the Vietnamese commercial banking system.The study was conducted in two steps. The first step of this study is to estimate the technical efficiency index of Vietnamese commercial banks using the DEA method. In the second step, the study uses the Tobit regression model to analyze the impact of income diversification on the operational efficiency of 34 Vietnam commercial banks in the period 2007 - 2015 in two groups: (i)

large-scale banks with average total assets in the study period greater than or equal to 100 trillion VND and, (ii) small-scale banks with average total assets less than 100 trillion VND. Finally, the research analyzes the results and gives some discussion.

2. Literature review

The research of Elyasiani and Wang (2012) showed that income diversification could improve bank efficiency through three main channels:

(i) Banks and financial institutions when diversifying operations would increase the competition in the market between financial institutions such as banks, finance companies and insurance companies. Competition increases forced banks to improve the efficiency of apparatus management and maintain competitive advantages by the progress of science and technology. These motivations helped banks and financial institutions improve bank efficiency (Jayaratne and Strahan, 1998).

(ii) Diversification could improve the efficiency of banks thanks to economies of scale through activities such as cross-selling, reuse of inputs, shared monitoring, advertising between products of banks and financial institutions. These advantages helped banks diversifying operations to be able to maintain competitive advantages and increase revenue compared to banks focusing on traditional business activities (Hughes et al., 2001; Stiroh, 2004).

(iii) Banks'efficiency can be enhanced through the sharing of customer information. Diamond (1984), Denis and Mihov (2003) think that the financial industry is highly information-intensive. Moreover, information is a considerably costly input in producing financial products and services. Saunders and Walter (1994), Kashyap et al. (2002) say that information, data about banks' customers or similar products will be shared with subsidiaries without additional costs.

Elyasiani and Wang (2012) also think that diversification may reduce bank efficiency through the results of empirical studies forfour main reasons:

(i) Improving bank efficiency by diversification through the exploitation of scale and scope economies only appears in the early stage when returns still keep increasing to scale. However, when maintaining a too large scale and conducting activity diversification may result in decreasing returns to scale and then reducing bank's operational efficiency (Wheelock and Wilson, 2001).

(ii) Diversification can reduce bank efficiency because it increases the complexity of a bank's structure and governance and make the supervision of banking operations less effective. As banks expand their activities to diversify income, this will increase information asymmetry and agency problems. Banks also often pursue management apparatus-building strategies. However, this increases costs and complexity of administration apparatus and leads to adecrease in bank efficiency (Hughes et al., 2003).

(iii) The expansion of activities to diversify income through mergers and acquisitions (M & A) can generate financial conglomerates witha "too-big-to-fail"status (DeYoung et al. 2009). These too big conglomerates will have fewer incentives in the business because they are guaranteed to be "bailed out" in the case of fail-

ure or collapse. Besides, debt-holders of these banking and financial conglomerates also have fewer incentives to monitor business activities, which results in decreasing the efficiency of these conglomerates.

(iv) Finally, diversification can reduce bank efficiency because of the dilution or loss of their "core competence". The research of Prahalad and Hamel (1990) showed that the diversification of banks into activities forced them to distribute and provide products, which they had little or no expertise or core competence in. This may have led to lower operational efficiency. Capon et al. (1988), Markides and Williamson (1994), Palich et al. (2000) indicated that the diversification of the business operations into fields which were not banks' strength or were less relatedto the main business activities, made operational efficiency decline.

Previous studies on the impact of income diversification on bank efficiency still remain inconclusive because there are many different study results. According to traditional views, the diversification into business activities helps banks spread the risks. However, an opposing view is that the expansion of traditional banking operations such as savingsdeposits,borrowingand lending will lead to greater risks for banks (Acharya, Hasan, and Saunders, 2006; Barry and Laurie (2010); Esho, Kofman, and Sharpe, 2005).

Vennet (2002) used the Stochastic Frontier Approach (SFA) to estimate the operational efficiency of European banks from 1995 to 1996 and analyze the effect of income diversification on bank efficiency. The results indicated that the specialized banksthat did not diversify had high effectiveness in costs and profits compared to the banks that diversified. Similarly, Acharya et al. (2006) used data from 105 banks in the period from 1993 to 1999 and came to theconclusion that income diversification of Italian banks did not help to increase operational efficiency.

Huang and Chen (2006) studied how the dependence on different sources of non-interest incomes affects bank efficiency. DEA was used in this research to calculate the cost efficiency of Taiwan commercial banks from 1992 to 2004. The results showed that the group of banks that had the highest or lowest rate of interest income and non-interest income from business activities had efficiency indexes that outperformed those with a middle rate of interest and non-interest incomes. This implied that banks in the diversification group with high or low interest levels will operate more cost-efficiently than the group of banks with a middle level.

The research result of Stiroh and Rumble (2006) indicated that income diversification and increased reliance on activities and non-interest income may raise risks and reduce the operational efficiency of banking and financial institutions.

Elyasiani and Wang (2012) studied the effect of income diversification on the efficiency of US banks over the period 1997 - 2007. The study employed Data Envelopment Analysis (DEA) to calculate bank efficiency. The results showed that activity diversification was negatively associated with the technical efficiency of banks. In addition, changes in diversification over time in the study did not affect the total productivity change (Malmquist), but had a negative impact on the change of technical effi-

ciency. Research results indicated that diversification lowers bank efficiency.

Besides, some other experimental research also found evidence about the positive relationship between income diversification and bank efficiency.

Chronopoulos et al. (2011) also examined the impact of income diversification on bank efficiency of four new countries joining the European Union in the period 2001 - 2007. The study also used Data Envelopment Analysis (DEA) to calculate bank efficiency. Research results showed that income diversification of commercial banks had a positive effect on increasing bank efficiency.

Lee et al. (2014) analyzed the impact of income diversification on bank efficiency by using the data of banks in 29 Asia-Pacific countries for the period 1995 - 2009. The results provided quantitative evidence regarding the positive effect of income diversification on operational efficiency of banks.

3. Research model

3.1. Income diversification

The study employs the Herfindahl Hirschman index (HHI) to estimate the degree of income diversification of commercial banks according to the research of Laeven and Levine (2007), Chronopoulos et al. (2011), Elyasiani and Wang (2012), Abdul (2015). The degree of income diversification of commercial banks is calculated by the equation:

$$HHI = 1 - \left[\left(\frac{non}{toiinc} \right)^2 + \left(\frac{net}{toiinc} \right)^2 \right] \quad (1)$$

Where HHI is the degree of income diversification of the bank researched; *net* and *non* are net interest income and non-interest income of the bank researched. According to the above equation, the higher the HHI index, the higher the degree of income diversification of the bank and vice versa. When the index is lower, it reflects the focus on business activities as well as a bank's income in the study.

3.2. Methods of measuring the bank efficiency

This study used the Data Envelopment Analysis (DEA) (Charnes et al., 1978) in accordance with a non-parametric approach to measure bank efficiency in the research through a technical efficiency (TE) index.

DEA is constructed on measuring operational efficiency based on the production frontier of enterprise, bank, or decision making unit (DMU). Assuming that there are n DMUs/ banks and they use m inputs and generates s outputs. Using X_{ik} inputs in order that the k^{th} DMU produce Y_{rk}. Where i represents the number of inputs, r represents the number of outputs and j is the order of the DMU/ bank. Variables u_{rk} and v_{ik} are weights of input and output variables respectively.

Ej is called the efficiency of DMU / jth bank. If Ej= 1, DMU / jth bank reaches maximum efficiency and Ej's value ranges from 0 to 1. For DMU / ineffective bank, DEA provides measures to adjust inputs / outputs with a view to help DMUs/ banks improve the unit's coefficients Ej (Ramanathan, 2006). Supposing that $\sum_{i=1}^{m} v_k X_k = 1$, the CRS model (Charnes et al.,1978) becomes:

$$MaxE_k = \sum_{r=1}^{s} u_{rk} Y_{rk} \quad (2)$$

Subject to:

$$\begin{cases} \sum_{r=1}^{s} u_{rk} Y_{rk} - \sum_{i=1}^{m} v_{ik} X_{ik} \le 0 \\ \sum_{i=1}^{m} v_{ik} X_{ik} = 1 \\ u_{rk}, v_{rk} \ge 0 \end{cases}$$

The CRS model is built to calculate the entire efficiency consisting of technical efficiency and allocative efficiency of the DMU / bank. Banker, Charnes and Cooper (1984) developed theVRS - Equation (3) based on the assumption that a return to scale split operational efficiency into technical efficiency and scale efficiency to calculate the level of technical efficiency of DMUs/ banks.

$$MaxTE_k = \sum_{r=1}^{s} u_{rk} Y_{rk} - \mu_0 \qquad (3)$$

Subject to:

$$\begin{cases} \sum_{r=1}^{s} u_{rk} Y_{rk} - \sum_{i=1}^{m} v_{ik} X_{ik} - \mu_0 \le 0 \\ \sum_{i=1}^{m} v_{ik} X_{ik} = 1 \\ u_{rk}, v_{rk} \ge 0 \end{cases}$$

In this study, the commercial banks are seen as the financial intermediaries. These banks provide financial services and payment services for entities in the economy, so the input variables are divided into 3 input variables: employee expenses (X1), fixed assets (X2); customer deposits (X3); and the output variables include interest income (Y1); non-interest revenue (Y2) including net income from services activities, net income from securities trading activities, investment, and net income from other activities.

3.3. Empirical research model

Based on studies of Simar and Wilson (2007), Elyasiani and Wang (2012), Abdul (2015), Curi et al. (2015), an experimental model is proposed for the study as follows:

$$TEi, \alpha + \beta * t = HHIi, t + \gamma * CSVi, t + ui, t \quad (4)$$

Where TEi, t is the technical efficiency of bank i at time t is measured according to the DEA.

$HHI_{i,t}$ is a variable used to measure income diversification of bank i at time t. The HHI index is calculated by the equation (1). The result expected is that when the HHI is higher, or the better commercial banks diversify income, the higher the operational efficiency of commercial banks will be

$CSV_{i,t}$ are control variables reflecting the characteristics of bank i at time t and having an effect on bank efficiency. The groups of control variables include: (i) the ratio of customer deposits to total assets, which is used to measure the ratio of customer deposits in the total capital structure of banks. The study expects to find that when the ratio of customer deposits to total assets (DTA) increases, Vietnam's commercial banks have the resources to expand business activities, thereby increasing operational efficiency; (ii) The capital structure of a bank is measured by the ratio of the equity to total assets (ETA). This factor shows the structure and the capital power of equity that a bank holds and is expected to have a positive relationship with bank efficiency; (iii) the ratio of total loans to total assets (LTA) measures credit scale of commercial banks. The research expects to find that when the scale of credit is expanded without factors affecting the quality of credits, bank efficiency will be increasingly improved; (iv) The quality of bank

Table 1: Description of regression variables

Variable	Description	Expectations sign	Related Research
Dependent variable			
TE	Technical efficiency under CRS	/	Huang and Chen (2006); Chronopoulos et al. (2011); Elyasiani and Wang (2012)
Independent variables			
HHI	Herfindahl Hirschman Index	+	Vennet (2002), Stiroh and Rumble (2006), Chronopoulos et al. (2011), Elyasiani and Wang (2012); Lee et al. (2014); Abdul (2015)
Control variables			
DTA	Total Customer Deposits/ Total Assets	+	Kwan (2006); Gaganis et al. (2013)
ETA	The ratio of equity book value tototal assets	+	Sufian (2009); Elyasiani and Wang (2012); Gaganis et al. (2013); Abdul (2015)
LTA	Gross Loans/ Total Assets	+	Kwan (2006); Sufian (2009); Elyasiani and Wang (2012); Gaganis et al. (2013); Abdul (2015)
RTL	Reserves for Impaired Loans / Gross loans (Loan Loss Reserve / Gross Loans)	-	Kwan (2006); Sufian (2009); Elyasiani and Wang (2012); Gaganis et al. (2013); Abdul (2015)
ROA	Return on Average Assets	+	Ismail et al. (2012); Elyasiani and Wang (2012); Gaganis et al. (2013).
SIZE	The logarithm of total assets	+	Kwan (2006); Lee and Kim (2013); Elyasiani and Wang (2012); Gaganis et al. (2013); Abdul (2015).

Source: Author's synthesis

assets is measured by the ratio of reserves for impaired loans to total loans (RTL). The higher the reserve ratio, the worse the quality of bank assets, which affects bank efficiency; (V) the profitability ratio of the bank is calculated by the return on total assets (ROA); (vi) The size of a bank is measured by the natural log of the total assets (SIZE) of bank. The study expects to find that the size of a bank is expanded to help the bank take advantage of economy of scale to increase operational efficiency.

Because the characteristics of dependent variables are blocked variables, they receive value ranges from 0 to 1. Therefore, the study used the Tobit regression model (or censored regression model) introduced by Tobin (1958). When the upper bounds of the efficient variable is 1, the lower is 0 and receivesa continuous value from 0 to 1.

The model analyzes the factors which affect

the resource efficiency of Vietnam commercial banks. It is conducted via Tobit regression analysis with the assistance of STATA software for unbalanced panel data in the study over the period 2007 – 2015. The number of banks in the study is 34 commercial banks.

3.4. Data

The data source of the article is taken from the Data Bank scope of Bureau van Dijk (2016), the annual reports of commercial banks and the official data of the State Bank of Vietnam along with other official data sources. To have a more specific analysis of bank scale, income diversification and bank efficiency, the research divided Vietnam's commercial banks in two groups: (i) large banks with average total assets during the study period greater than or equal to 100 trillion VND and (ii) small banks with average total assets less than 100 trillion VND.

According to the classification criteria, the group of banks with an average total assets size greater than or equal to 100 trillion VND consists of 10 banks: CTG, AGR, VCB, SCB, STB, MBB, SHB, ACB, VPB and TCB. The other group includes 24 commercial banks with average total assets scale less than 100 trillion VND: EIB, PVB, LVP, HDB, MSB, EAB, SAB, VIB, TPB, OCB, ABB, ANZ, SHA, OCB , GDB, IND, SDB, PGB, KLB, VEB, SGB, VID, MHB and HLB.

4. Empirical results

4.1. Descriptive statistics

Statistical results describe the input and output variables in the bank efficiency analysis model by the size of banks show that the average employee expenses (X1) of 34 banks in the study reaches 1014.43 billion VND of which large-scale banks with average employee costs are more than 6.5 times greater compared to-those of small-scale banks. The input variable with the highest average value is the scale of customer deposits (X3) reaching 75509.77 billion VND in the research period. The average deposits size of 10 large-scale commercial banks reaches 161463.20 billion VND and is more than 6.11 times the 26393.55 billion VND of 24 small-scale banks.

Regarding the average value of the whole system, the main revenue of the commercial banking system in Vietnam in the research period is primarily earned from traditional credit activities. They account for over 90% of the revenue of the whole interest income scale system, reaching 6869.35 billion VND while non-interest income only reaches 728.06 billion VND. The group of large-scale banks has output revenue much greater than the average level of the small-scale group. Average interest and non-interest income of the group of large-scale banks is more than 6.59 times and 6.01 times compared to the group of small-scale banks, respectively.

Statistical analysis results described in Table 3 show that the HHI index measures the degree of average diversification of Vietnamese commercial banks in the study reaching a low level of 0.193. The group of large-scale banks reaches a better income diversification degree than the group of small-scale banks with an HHI index of 0.199 and 0.189 respectively.

The ratio of customer deposits to total assets (DTA) of the entire system has an average level of 0.599. However, this ratio in small-scale banks only reaches 0.599 while this ratio is up to 0.669 in large-scale banks. The ratio of

Table 2: Summary of Outputs and Inputs

In billion VND

	Number of observations	Mean	SD	Min	Max
X1	220	1014.430	1635.653	9.030	10292.500
X2	220	812.620	1201.819	13.200	8015.000
X3	220	75509.770	103600.200	152.940	568691.900
Y1	220	6869.347	10714.340	4.560	67721.800
Y2	220	728.064	1012.550	0.000	5266.600
Large banks					
X1	80	2199.033	2248.605	85.400	10292.500
X2	80	1689.588	1616.630	97.170	8015.000
X3	80	161463.200	130606.600	9508.140	568691.900
Y1	80	14929.120	14406.350	836.900	67721.800
Y2	80	1550.883	1262.104	0.000	5266.600
Small banks					
X1	140	337.514	268.880	9.030	1148.900
X2	140	311.496	307.787	13.200	1865.200
X3	140	26393.550	23098.670	152.940	101371.900
Y1	140	2263.765	2039.680	4.560	10435.400
Y2	140	257.882	312.557	0.000	1918.790

Source: Bureau van Dijk (2016) and author's computation

the equity to total assets (ETA) of banks in the study has an average of 0.137, but the group of small-scale banks maintains an ETA higher than the group of large-scale banks.

The ratio of total loans to total assets (LTA) on average inthe study reaches 0.502. The group of large-scale banks maintains an LTA (0.552) greater than the group of small-scale banks (0.474). The ratio of reserves for impaired loans to total loans (RTL) on average forthe group of large-scale banks reaches 1.7% while for small-scale banks it only reaches 1.4%, which makes the average rate of the whole study group remain at 1.5%. Detailed descriptive statistics of the bank scale and return on total assets are presented in Table 3.

Technical efficiency

Bank efficiency in this study is measured by a technical efficiency index by using non-parametric analysis in accordance with Data Envelopment Analysis (DEA) through the Data Envelopment Analysis Program Version 2.1 (Coelli et al., 2005). According to Coelli et al. (2005), an economic unit is seen to be more effective than another unit if it can deliver more goods and services for society without using more resources than other units. In other words, the unit reaches effectiveness if it reaches the maximum output result in conditions usingthe given optimal input result. Technical efficiency is the ability to use the minimum inputs to produce a given unit of output, or the possibility

Table 3: Descriptive statistics of regression variables

	Number of observations	Mean	SD	Min	Max
HHI	220	0.193	0.129	0.000	0.490
DTA	220	0.599	0.151	0.048	0.892
ETA	220	0.137	0.123	0.026	0.943
LTA	220	0.502	0.154	0.037	0.944
RTL	220	0.015	0.008	0.000	0.050
ROA	220	0.011	0.011	-0.060	0.080
SIZE	220	10.939	1.279	7.790	13.570
			Large banks		
HHI	80	0.199	0.109	0.000	0.480
DTA	80	0.669	0.111	0.355	0.892
ETA	80	0.077	0.022	0.026	0.158
LTA	80	0.552	0.125	0.331	0.837
RTL	80	0.017	0.010	0.000	0.050
ROA	80	0.011	0.007	0.000	0.030
SIZE	80	12.061	0.843	9.570	13.570
			Small banks		
HHI	140	0.189	0.140	0.000	0.490
DTA	140	0.559	0.157	0.048	0.889
ETA	140	0.171	0.142	0.052	0.943
LTA	140	0.474	0.162	0.037	0.944
RTL	140	0.014	0.007	0.000	0.030
ROA	140	0.011	0.013	-0.060	0.080
SIZE	140	10.298	1.018	7.790	12.120

Source: Bureau van Dijk (2016) and author's computation

of obtaining the maximum output from a given input unit.

Statistical results of technical efficiency are presented in Table 4. They show that the technical efficiency under assumption about Constant Returns to Scale (CRS) of 34 commercial banks in the research has an average of 85.8 %, which means that 34 commercial banks only use 85.8 % of the input to generate the same output. In other words, commercial banks in the study use inefficient inputs of 16.55 % (technical inefficiency = 1 / technical efficiency -1). Besides, the group of 10 large-scale commercial banks reaches anaverage technical efficiency of (86.1 %), which is higher than the average efficiency of the group of 24 small-scale commercial banks (85.6%).

4.2. Diversification and bank efficiency

The analysis results of the income diversification's effect on operational efficiency of Vietnam commercial banks under the Tobit re-

Table 4: Technical efficiency for banks under DEA

	Number of observations	Mean	SD	Min	Max
TE_CRS	220	0.858	0.165	0.030	1.000
Large banks					
TE_CRS	80	0.861	0.132	0.400	1.000
Small banks					
TE_CRS	140	0.856	0.182	0.030	1.000

Source: Bureau van Dijk (2016) and author's computation

gression model are presented in detail in Table 5.

Results of empirical regression analysis show the positive relationship between the degree of income diversification (HHI) and operational efficiency (TE_CRS) of Vietnamese commercial banks in the research period with the regression coefficient 0.397 and significance at 1%.

The regression results are consistent with previous empirical studies of Chronopoulos et al. (2011), Lee et al. (2014). The results reflect the activity diversification promoting the revenue diversification ofVietnamese commercial banks, which increases the more effective use of inputs, thereby increasing the operational efficiency of commercial banks in Vietnam.

The ratio of customer deposits to total assets has a negative impact on the performance of commercial banks in the research and has significance at the 1% level. This result shows that the maintenance of a too large customer deposits scale will create pressure on interest for depositors, increase costs and reduce the operational efficiency of commercial banks. However, when the customer deposit ratio is too low, commercial banks will have trouble building a source of capital to conduct profitability operations to improve bank efficiency. The previous empirical studies of Kwan (2006) also supported the results of the research carried out in Vietnam. The researches of Sufian (2009) and Elyasiani and Wang (2012) also have the same results. The ratio of the equity to total assets also has a negative impact on operational efficiency of commercial banks and has significance at 1 %. When the equity capital ratio increases, although banks will have more resources to ensure the safety of banking activities and implement investment operations to generate profits, along with these benefits is the pressure to pay dividends for shareholders, thus reducing bank efficiency.

The ratio of total loans to total assets indicates that the scale of credit activities hasapositive effect on the operational efficiency of Vietnamese commercial banks and affects as was the initial expectation of the study. The studies of Sufian (2009), Elyasiani and Wang (2012) and Abdul (2015) have shown a positive relationship between the scale of credit activities and bank efficiency in the expectation that when the credit size becomes larger with guaranteed quality, this will help to increase bank efficiency.

The results in Table 5 also show that the variables measuring the quality of bank assets (RTL), the profitability (ROA), and the size

Table 5: The effects of bank income diversification on bank efficiency

Dependent variable: TE_CRS

	Coef. (P-value)	Z		Coef. (P-value)	Z
HHI	0.397* (0.000)	3.990	HHI2	0.809* (0.000)	3.600
DTA	-0.412* (0.000)	-4.090	DTA	-0.399* (0.000)	-3.940
ETA	-0.437* (0.004)	-2.870	ETA	-0.456* (0.003)	-3.010
LTA	0.381* (0.000)	3.740	LTA	0.387* (0.000)	3.730
RTL	0.400 (0.794)	0.260	RTL	0.334 (0.828)	0.220
ROA	1.373 (0.191)	1.310	ROA	1.522 (0.150)	1.440
SIZE	-0.004 (0.808)	-0.240	SIZE	-0.004 (0.785)	-0.270
Constant	0.927* (0.000)	4.760	Constant	0.955* (0.000)	4.980
/Sigma_U	0.073* (0.000)	4.330	/Sigma_U	0.070* (0.000)	4.260
/Sigma_E	0.134* (0.000)	18.650	/Sigma_E	0.136* (0.000)	18.770
Rho	0.227		Rho	0.208	

*Notes: *, **, *** denotes significance at the 1%, 5% and 10%level*

Source: Author's computation

of the bank, have no meaning in the model analyzing the effect of income diversification on bank efficiency in the research period. To increase the reliability of the study as well as to test the non-linear relationship between income diversification and operational efficiency of commercial banks, the HHI2 variable, the square of the HHI index, is supplemented into the regression model (4). The results of the regression model are also presented in Table 5. It again affirms the meaning level and the positive relationship with the pattern (4) of the DTA, ETA and LTA variables. The variables: RTL, ROA and SIZE have no meaning in the non-linear model.

To have a more detailed analysis of the impact of income diversification on operational efficiency according to the scale of banks, the study conducted the regression analysis by grouping banks according to large scale and small scale,as in the previous classification.

The regression results presented in Table 6 show that the degree of income diversification of the group of large-scale banks has a stronger effect on operational efficiency compared to the group of small-scale commercial banks. The result also confirms the positive relationship and has the statistical significance of income diversification on operational efficiency for both groups of commercial banks classified by size as in the research of Chronopouloset al. (2011), Lee et al. (2014) and in the empirical

Table 6: Tobit regression results on determinants of technical efficiency

Dependent variable: TE_CRS

Large banks			Small banks		
	Coef. (P-value)	*Z*		*Coef. (P-value)*	*Z*
HHI	0.437** (0.037)	2.090	HHI	0.403* (0.001)	3.470
DTA	-0.151 (0.373)	-0.890	DTA	-0.517* (0.000)	-4.110
ETA	-1.991** (0.023)	-2.270	ETA	-0.353** (0.057)	-1.910
LTA	0.230 (0.242)	1.170	LTA	0.529* (0.000)	4.090
RTL	-1.887 (0.316)	-1.000	RTL	2.444 (0.294)	1.050
ROA	1.058 (0.692)	00.400	ROA	1.613 (0.191)	1.310
SIZE	-0.043 (0.120)	-1.560	SIZE	0.020 (0.474)	0.720
Constant	1.446* (0.000)	3.850	Constant	0.622** (0.052)	1.940
/Sigma_U	0.056** (0.029)	2.180	/Sigma_U	0.067* (0.005)	2.840
/Sigma_E	0.109* (0.000)	11.210	/Sigma_E	0.145* (0.000)	14.440
Rho	0.206		Rho	0.176	

*Notes: *, **, *** denotes significance at the 1%, 5% and 10% level*
Source: Author's computation

models of all banks in the study presented in Table 5.

5. Conclusion and recommendations

The study has used the Herfindahl Hirschman (HHI) index to estimate the degree of income diversification of the Vietnamese commercial bank system from 2007 to 2015. The descriptive statistics result shows that the average HHI index of commercial banks reaches0.193 when conducting income diversification, but the result reflects the low-level diversification. In addition, more than 90% of the revenue of the entire system still comesfrom the traditional credit operations.

The frontier efficiency analysis with Data Envelopment Analysis Program Version 2.1 shows the system reaches 85.5 % of the average efficiency level or the level of resource waste has still amounted to 16.55 % - this is the basis for Vietnamese commercial banks continuing to adjust the scale of input resourcesand increasingthe efficiency of the administration apparatus to improve operational efficiency. The results also reflect that the group of 10 large-scale commercial banks maintain technical efficiency levels at an average level of (86.1%), higher than 24 small-scale commercial banks (85.6%).

The next step of the research uses the Tobit regression model with other control variables to assess the effect of income diversification on the operational efficiency of Vietnamese com-

mercial banks. The study results show a positive relationship between income diversification and bank efficiency. It also indicates that the group of large-scale banks has a greater impact of income diversification on operational efficiency compared to the group of small-scale banks. Empirical research results with descriptive statistics show that Vietnamese commercial banks can continue to improve operational efficiency through: (i) Continuing to conduct income diversification through activity diversification and focusing on developing modern services to enhance the ratio of non-interest income of the bank; (ii) Expanding the scope of banking activities to take advantage of economy of scale and reducing costs to improve the efficiency.

Although the study has achieved some particular results as the initial research objective has been set, it still has some limitations that future studies can overcome or continue to deploy to make more comprehensive contributions. The main limitations of the study are: (i) The cost efficiency (CE) of commercial banks has not yet been analyzed due to the lack of data on input resource prices of the banks; (ii) The different sources of non-interest revenue are not divided because of having no data; (iii) The study also did not specify a scale threshold as well as the optimal income diversification for Vietnamese commercial banks.

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