How Non – Interest Income Matters for Operation Efficiency? A Bayesian Analysis of Vietnam Banks

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Abstract. This study tries to determine how non–interest revenue may affect 30 commercial banks in Vietnam's probability ratio between 2011 and 2020. Using the Bayesian regression technique, secondary data from 30 commercial banks was used to determine the effect of non–interest income on the probability ratio. Regression analysis reveals that non – interest revenue, bank size, debt to equity ratio, operational expenses, deposit rate, and inflation have a positive and statistically significant impact on the operating performance of Vietnamese commercial banks. In contrast, neither the GDP growth rate nor the provision for bad debts have a statistically significant impact on the profitability of Vietnam's commercial banks.

Keywords: commercial banks · non–interest income · operational efficiency

1 Introduction

In recent years, the world banking industry has had great changes in technology, competitive environment, customer needs, etc. These are the reasons for the continuous development of products and non–traditional service. The expansion of policies as well as forms of non–traditional financial products and services, combined with attractive interest rates to attract customers, are being used by banks to become more popular, richer and more attractive. The bank's non–interest income comes from service fees, commissions, insurance, securities, etc. From here, banks can attract a large number of customers and increase their competitiveness against competitors in the same industry, increase the income of banks; and this is also an inevitable trend for the survival and development of commercial banks in developed countries.

Currently, in the world and in Vietnam, there are two sources of conflicting research results on the impact of non–interest income on the probability ratio of banks. According to research by Baele et al. (2007), thanks to the expansion of non–traditional activities, banks can have more opportunities to access new information sources, facilitate cross–selling of products, develop other products and services that have a more positive impact

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on the business relationship. Some other studies also show a positive impact from non–interest income, non–traditional activities that help banks reduce risk such as Saunders, Schmid and Walter (2014), Singh and Upadhyay (2016), etc. Domestic studies also reached the same conclusion as Le Long Hau and Pham Xuan Quynh (2016), Ho Thi Hong Minh and Nguyen Thi Canh (2015), etc. However, there are also studies that give conflicting conclusions, when non–interest income increases risk as studied by Lepetit, Nys, Rous, and Tarazi (2008); Li and Zhang (2013); Williams (2016). They believe that the expansion of non–traditional business activities will lead to banks consuming large amounts of fixed costs, increasing operating leverage and higher risks. Because there are many multi–dimensional studies, from here, the question arises whether non–interest income really has a positive impact on the bank's probability ratio or vice versa, it will have an impact on the profitability of banks, and at the same time increase the risk of bankruptcy according to previous research by some authors. To answer and contribute to meet the practical ability to Vietnam, the author chooses to research the topic: "The impact of non–interest income on the probability ratio of Vietnamese commercial banks" to be able to provide a complete view and appropriate direction for commercial banks.

2 Literature Review

2.1 Theoretical Basis

2.1.1 Operational Efficiency of Commercial Banks

According to Farrell (1957), efficiency represents the correlation between the obtained output variables and the input variables that were used to produce those outputs. In which, cost efficiency or economic efficiency includes technical efficiency and allocative efficiency. Technical efficiency is an indicator that represents the maximum production capacity of a unit with a given input, while allocative efficiency is used to reflect the ability to optimize inputs when prices are known. Therefore, efficiency can also be said to be the benefits brought from specific activities in the form of input optimization and output maximization.

According to the point of view expressed in the research papers of Elyasiani and Mehdian (1990a, 1990b) and Mester (1987), the output in the operation of commercial banks as financial intermediaries is the assets of banks, while the deposits, labor and capital are inputs. The most important thing in the bank's profit structure is interest income, and depends on the credit extension (namely lending). Therefore, credit development is very important for banks. In which, loan capital is considered as a product and loan interest rate is considered as the price of that credit.

According to Antonio, Ludger and Vito (2006), efficiency is seen as a comparison between inputs and outputs or between profits and costs. With the same level of input defined, the activity that produces more output is the more efficient operation. Efficiency is considered to be the degree to which firms or banks complete the allocation of usable inputs and the outputs they produce, meeting set goals (Nguyen Khac Minh 2004).

It can be understood, the operating system of a commercial bank is like the ability to generate profits of that commercial bank while limiting risks and all activities of the bank are still in accordance with the set goals. According to Chang et al. (2010) also

stated that efficiency also reflects the ability to manage, control costs and use resources to create outputs.

Commercial banks are an intermediary financial institution that plays a very important role in the market economy, there are always activities to transfer capital from places of excess to places of shortage (Peter 2014), but if viewed from the perspective of an enterprise, business activities must always have a combination of two factors, which is to maximize profits, but within the allowable risk level – the risk that commercial banks can accept.

Based on the above concepts, it can be concluded that the operating system of commercial banks is a collection of many factors such as financial resources, human resources, facilities and other factors in the operation of the bank. In the current integration context, focusing on the current business relationship is imperative and indispensable for each bank, contributing to creating the intrinsic value of each bank in the ever–changing market economy.

2.1.2 Income of Commercial Banks

Net Interest Income: Commercial banks provide capital mobilization products, loan products and a number of other business activities (domestic and international payments; domestic and foreign money transfer; salary collection and payment; SMS Banking; Internet Banking; trading in foreign currencies, gold and silver, cards; investing in government bonds, contributing capital to joint ventures; discounting commercial papers, bonds, valuable papers etc.). In which, lending activities play an important role in generating income of banks. The source of income from lending activities is called interest income – always accounts for a high proportion in all banks. Net interest income is the difference between the income from lending activities and the expenditure on capital mobilization activities. In other words, the gap between lending rates and deposit rates is net interest income (Hoang Ngoc Tien and Vo Thi Hien 2010). Net interest income depends on the interest rate management policy of each bank. Besides, other factors such as economic conditions, the flourishing of business lines, etc. are also factors affecting interest income. Interest income depends on the loan interest rate, outstanding balance and ability to cooperate in debt repayment. Although this source of income plays a key role in banking activities, it has many potential risks, because the loans depend on the economic situation of the customer, leading to the degree of cooperation in repayment of the customer. In addition, other factors such as economic conditions, the development of business lines, etc. are also factors affecting interest income.

Non–Interest Income: The calculation of income from non–interest business activities of commercial banks is based on the income structure including interest income (mainly coming from the bank's lending activities, this is the main source of income for the commercial banks) accounts for the largest proportion of total revenue of the bank and non–interest income. The source of income from activities other than credit activities is called non–interest income. According to Hoang Ngoc Tien and Vo Thi Hien (2010), private equity is being interested by banks in order to spread risks and reduce dependence on main sources of income, in which non–interest income is income from services, trading in foreign exchange, gold, silver, gems; securities trading and other service

activities. Stiroh (2004) argues that non–interest income is a heterogeneous category that includes many different activities, divided into four main components: trust income, service fees, fees. Therefore, based on the annual reports of banks, non–interest income includes: income from service activities, fees, commissions, income from investment business activities (foreign exchange, gold, trading and trading securities, investment securities trading, income from capital contribution, share purchase), other non–interest income. In general, the higher the ratio of non–interest income, the greater the bank's sensitivity to changes in interest rates.

2.1.3 The Impact of Non–interest Income on the Operating Performance of Commercial Banks

Business relations are always a matter of concern to economic organizations as well as banks. The Bank's effective business operations demonstrate the Bank's capacity to customers and partners, and at the same time attract investors, thereby ensuring the stability and development of the Bank. Therefore, improving operational efficiency is always one of the top concerns of banks. The evaluation of the operational performance of commercial banks is not only of great significance for banks in considering the overall use of resources, enhancing competitiveness, but also for the management agencies of State in supporting and creating conditions for banks to operate better.

When non–interest income generating activities such as business, investment, payment services, card services are developed, commercial banks will make optimal and effective use of technical facilities, as well as human resources of each bank. Therefore, management costs and operating expenses are reduced, increasing the maximum profit for the bank. Expanding non–interest activities also helps banks to disperse and reduce risks, especially credit risks. Theoretically, in all activities that bring profits to banks, the activities of income diversification, increasing the ratio of non–interest income are very preferred by banks because of service fees, business profits. Net and non–interest income are not completely correlated with net interest income. Therefore, increasing non–interest income ratio leads to more stable operating income and better adjusted financial risk (Odesanmi and Wolfe 2007).

DeYoung and Rice (2004a) study the relationship between non–interest income and financial performance in the commercial banking industry in the US from 1989 to 2001. The results show that the rate of non–interest income has a positive effect on ROE. Similarly, Chiorazzo et al. (2008) using data of banks in Italy during the period 1993–2003, the authors also concluded that increasing non–interest income will increase the operational efficiency of banks, adjusting for systemic risk of banks in Italy and this relationship will be stronger in larger banks. According to a study by Baele et al. (2007) using panel data of banks in Europe from 1989 to 2004 it was concluded that an increase in non–interest income will increase the operational efficiency of banks. Besides, Busch and Kick (2009) also studied the impact of fee–based income on the profitability of banks from 1995 to 2007 in Germany. The results show that high fee–based income can increase profitability, adjust bank risk. Or according to Elsas et al. (2010) studied the impact of income diversification on both bank performance and market value using panel data of nine countries from 1996 to 2008. They found that income diversification can improve

bank profitability and market value. In addition, Lozano–Vivas and Pasiouras (2010), Gamra and Plihon (2011), Meslier et al. (2014) also argue that when the financial market is increasingly integrated, banks must strengthen their competitiveness through through a business diversification strategy. Since non–interest income generating businesses such as underwriting, brokerage and other consulting services often have a weak/unclear relationship with traditional credit operations, diversifying income sources will be a lifeline for the bank's profits when lending activities go wrong.

Studies in Vietnam also come to similar conclusions as Le Long Hau and Pham Xuan Quynh (2016), Ho Thi Hong Minh and Nguyen Thi Canh (2015), Vo Xuan Vinh and Tran Thi Phuong Mai (2015).

However, there are also studies that show different perspectives and results. For example, Stiroh (2004) using data from commercial banks in the US in the period 1970 to 2001, the author concludes that non–interest income has a positive impact on the risk of insolvency of commercial banks, that is, is income diversification leading to commercial bank's inability to pay. Or according to Mercieca et al. (2007) study whether non–interest income improves the performance of small credit institutions in Europe or not. Using a sample of 755 small banks in the period 1997–2003, the authors found an inverse relationship between non–interest income and bank performance. Besides, Lepetit et al. (2008) studied the relationship between banking risk and product diversification in the changing structure of the European banking industry. Based on a series of European banks between 1996 and 2002, our research shows that banks that expand into non–interest income activities have higher risk and higher risk of insolvency compared to banks. Banks mainly provide loans.

2.2 Comprehensive Researches

2.2.1 Comprehensive Researches in Vietnam

Ho Thi Hong Minh and Nguyen Thi Canh (2015) have focused on examining the relationship between the private diversification of banks and factors affecting profitability of Vietnamese commercial banks. This study uses data collected from the financial statements of 22 Vietnamese commercial banks in the period 2007–2013, processed through the SGMM method. The results show that the ratio of income diversification (the contribution ratio of non–interest income), the ratio of outstanding loans to total assets, the ratio of operating expenses to income are negatively correlated with profitability; In which, the expansion of non–profit business activities to help Vietnamese commercial banks increase profitability and develop service activities in parallel with credit activities is an inevitable development trend of Vietnamese commercial banks in the context of economic situation is increasingly difficult and competition is fierce.

Le Long Hau and Pham Xuan Quynh (2016) pointed out that the implementation of self–diversification by expanding products and services will have a positive impact on the bank's business performance; at the same time, it also shows that net non–interest income sources, loan balance, equity size, bank size, economic growth rate, and inflation have a positive impact, while, operating costs, the activities and money of customers have a negative impact on the business performance of commercial banks. The article, through the processing of data collected from financial statements and annual reports

of 26 Vietnamese commercial banks in the period 2006–2014 using FEM and REM models also shows that the increase in the ratio of external income Interest rates are beneficial for Vietnamese commercial banks in addition to racing with credit growth (risky activities and high probability of bad debt). Therefore, in the current period of integration and increasingly fierce competition, the expansion of non–interest income generating activities, especially service activities, is necessary to increase income and improve efficiency business for commercial banks.

Nguyen Minh Sang and Nguyen Thi Thuy Trang (2018) analyzed the impact of non–interest income on the risk and profitability of 26 Vietnamese commercial banks from 2008 to 2016 using a panel data analysis model. The study uses the ratio of non–interest income to net operating profit to measure non–interest income. Research results show that non–interest income has no impact on risk but has a positive effect on profitability of commercial banks (typically, ROA) during the research period. This is a good sign for banks that want to diversify their private equity, especially non–interest income from non–traditional activities to improve competitiveness, limit risks and increase profits.

Nguyen Thi Diem Hien and Nguyen Hong Ha (2016) study on factors affecting non–interest income and its impact on financial performance of 33 joint stock commercial banks in the period 2006–2013. The results show that non–interest income has a positive impact on financial performance and reduces the volatility of financial performance. At the same time, the study points out that bank–specific factors and market conditions affect non–interest income.

Trinh Thi Thuy Hong, Nguyen Hoang Phong and Le Tien Thanh (2018) have shown that expanding non–interest business activities has a positive impact on business activities of state–owned commercial banks or in other words, private diversification has strong impact on state–owned commercial banks through annual panel data collected from a group of 29 Vietnamese commercial banks provided by Bankscope during the period from 2006 to 2016 with about 287 observations through the FEM and FGLS.

2.2.2 Comprehensive Researches in the World

Al–Tarawneh, Abu Khalaf and Al Assaf (2017) study the impact of non–interest income on the operations of 13 banks in Jordan during the period from 2000–2015 using a model FEM. The results indicate that bank size, loans, capital adequacy and overhead are found to have a significant impact on the performance of banks. Specifically, general costs reduce the bank's operating efficiency, while the level of capital adequacy, loans and bank size increase the bank's operating efficiency. In addition, non–interest income increases the safety of equity and this in turn has a positive effect on profitability.

Bailey–Tapper (2010) studied panel data of Jamaican commercial banks from March 1999 to September 2010 on the determinants of non–interest income. Research results show that: ATM technology, personal lending and loan quality are among the main microeconomic factors promoting non–interest income performance in the commercial banking sector. Regarding the macroeconomic environment, interest rates and exchange rate fluctuations are the main factors that explain the effect of non–interest income. In this context, the effect of stronger non–interest income not only increases profitability but also increases business efficiency. In addition, large banks have lower income in investment leading to increased service costs from loans and may reflect loans more

positively because these institutions increase fee income. In addition, lower income on investment also contributes to the higher "other" service costs of larger banks and it may reflect greater competitive demand, especially in the low interest rate environment of the period latter part of the Jamaican debt exchange.

Chiorazzo, Milani and Salvini (2008) used annual data from 85 Italian banks for the period 1993–2003, regression by FEM model to investigate the relationship between income non–interest income and profitability. The results show that the diversification of the private sector, the expansion of non–profit business types will increase the profits of banks. Small banks can benefit from increased non–interest income, but only if they have very little non–interest income to start a business. The study of Baele et al. (2007) also agrees with the above results. Accordingly, Baele et al. (2007) show that private banking helps banks to obtain customer information more easily, contributing to promoting cross–selling of products and enhancing other services.

Craigwell and Maxwell (2005) studied the trend of non–interest income at commercial banks in Barbados from 1985 to 2001, as well as study the determinants of non–interest income and its impact it affects the financial performance of commercial banks. The results indicate that the ratio of non–interest income in Barbados has decreased during this period. Analysis of the literature and panel data regression models suggest that the results for Barbados may be due to the absence of some of the most important factors in non–interest income generation in developed countries, such as deregulation and technological change, especially to develop loan securitization and credit risk assessment. Empirical evidence supports the characteristics of banks and ATM technology as the most influential factors shaping non–interest income trends in the banking industry in Barbados. In addition, non–interest income has a positive effect on both bank profitability and income volatility, indicating that non–interest income has a positive impact on bank profitability and income. Factors related to ATM technology affect non–interest income.

DeYoung and Rice (2004a) pointed out that non–interest income currently accounts for more than 40% of operating income for commercial banks in the US. The study also presents some empirical links between non–interest income of banks, business strategy, market conditions, technological change and financial performance from 1989 to 2001. The results show diversification to help banks reduce risks in business activities. Commercial banks take advantage of advanced technology for non–cash transactions to collect more fees to increase non–interest income. The study argues that non–interest income should co–exist with interest income from intermediary activities (rather than replacing or completely replacing), as these activities remain core financial services functions of banks.

Oniango (2015) argues that non–interest income is considered as an additional source of income for commercial banks, which is essential to improve profitability of commercial banks in Kenya. The study sought to determine the effect of non–interest income on the profitability of commercial banks in Kenya. To achieve this goal, the author used a descriptive survey. The subjects of the study included all 43 commercial banks in Kenya. Data analysis was performed using a regression model. Research shows that non–interest income has a positive impact on profitability of commercial banks. The results show that there is a moderate correlation between non–interest income and

profitability of commercial banks. The study recommends that companies should offset the risks of doing business. Similarly, the study by Som Raj Nepali (2018) examines the impact of private equity on the risk–return trade–off principle at Nepalese commercial banks, using secondary data collected from 20 Nepalese commercial banks since 2009 as well shows that non–interest income, foreign ownership ratio and bank size are positively correlated with risk–adjusted return.

Tarazi, Crouzille and Tacneng (2010) examine the impact of private diversification on the performance of banks in an emerging economy. The study shows that, in contrast to studies on the Western economy, the shift to non–interest–bearing activities increases banks' profits and especially risk–adjusted returns when banks are more involved in trading in government securities. Foreign banks benefit more from this change than domestic banks. In addition, the study also takes into account the institutional and legal environment that supports loans to SMEs and finds that more participation in non–interest activities only benefits low–risk banks for SMEs.

Trujillo–Ponce (2013) empirically analyzed the determinants of profitability of Spanish banks in the period 1999–2009. The results show that the high profitability of the bank in these years is related to the large loan ratio in total assets, the high proportion of customer's deposits, and the low ratio of bad assets. In addition, the study did not find statistical significance in the variable measuring the effect of income diversification on the profitability of banks, showing that non–interest income activities do not affect the profitability of banks in the Spain.

It is noteworthy that the research mentioned above used frequency approaches or descriptive analyses with suitable large sample sizes. This study, however, used Bayesian logistic regression with informative priors to assess how non–interest revenue may affect 30 commercial banks in Vietnam's probability ratio between 2011 and 2020. The following contributions from the research have been as anticipated: Firstly, commercial banks will operate more efficiently if they move in the direction of increasing the proportion of non–interest income–generating businesses. Secondly, our results allow a broader conclusion that, in contrast to frequentist approaches, Bayesian estimation employing thoughtful priors can produce meaningful results. This generalization is made possible by using Bayesian MCMC simulations in informative (thoughtful) prior settings.

3 Models and Method

3.1 Data Collection Methods

The study uses panel data, which is based on numerical data obtained from different sources. The first data source is from the audited financial statements and annual reports of thirty (30) commercial banks in Vietnam in the period 2011–2020 from the websites of commercial banks. The second data source is taken from the websites of international organizations, including open data of the World Bank, the General Statistics Office of Vietnam to ensure the reliability of the research.

3.2 Research Models

From the point of view of inheriting and continuing to develop previous studies, the thesis uses the research model of Chiorazzo et al. (2008) and edited by Le Long Hau and

Pham Xuan Quynh (2017) to suit conditions of Vietnam. In fact, there are many previous studies that have chosen ROA to study the operational performance of banks. Therefore, in this study, the author chooses ROA as dependent variables. Besides the typical factors of the bank are non–interest income, size of bank, scale of credit activities, capital structure, operating costs, deposit size and macro factors such as economic growth rate and inflation; according to the studies of Weersainghe and Perera (2013); Sufian and Habibullah (2009); Ahmad (2014); Nguyen Thanh Phong (2015) can show that the asset quality of banks (LLP) is one of the variables that have an impact on the bank's operational performance. Realizing that the asset quality ratio of banks is mentioned in many studies, the author decided to add the asset quality variable of banks to improve the accuracy of the model. Therefore, the proposed model for this study is as follows:

$$\mathbf{ROA_{i,t}} = \alpha + \beta_1 * \mathbf{ICO_{NON_{i,t}}} + \beta_2 * \mathbf{SIZE_{i,t}} + \beta_3 * \mathbf{LOAN_{i,t}} + \beta_4 * \mathbf{EQUITY_{i,t}} + \beta_5 * \mathbf{COST_{i,t}} + \beta_6 * \mathbf{DTL_{i,t}} + \beta_7 * \mathbf{LLP_{i,t}} + \beta_8 * \mathbf{GDP_t} + \beta_9 * \mathbf{INF_t} + \mathbf{u_{i,t}}$$

In which:

ICO_{NON} – Non–Interest Income Ratio: According to Chronopoulos et al. (2011), Elyasiani and Wang (2012), Abdul (2015), Chiorazzo et al. (2008), Stiroh and Rumble (2006), Ho Thi Hong Minh and Nguyen Thi Canh (2015), Le Long Hau and Pham Xuan Quynh (2017), the ratio of non–interest income of commercial banks is estimated by the formula:

$$\begin{aligned} \mathrm{ICO_{NON}} &= (\mathrm{ICO_{COM}} + \mathrm{ICO_{TRAD}} + \mathrm{ICO_{OTH}}) \times 100(\%) \\ &= \left(\frac{\mathrm{COM}}{\mathrm{NET} + \mathrm{NON}} + \frac{\mathrm{TRAD}}{\mathrm{NET} + \mathrm{NON}} + \frac{\mathrm{OTH}}{\mathrm{NET} + \mathrm{NON}}\right) \times 100(\%) \\ &= \frac{\mathrm{COM} + \mathrm{TRAD} + \mathrm{OTH}}{\mathrm{NET} + \mathrm{NON}} \times 100(\%) \\ &= \frac{\mathrm{COM} + \mathrm{TRAD} + \mathrm{OTH}}{\mathrm{NETOP}} \times 100(\%) \end{aligned}$$

In which:

- ICO_{NON}: ratio of non–interest income
- ICO_{COM}: percentage of net income from service activities
- ICO_{TRAD}: ratio of net income from business activities, investment
- ICO_{OTH}: ratio of net income from other non–interest activities
- COM: net income from service activities
- TRAD: net income from business activities, investment
- OTH: net income from other non–interest activities
- NON: net income other than interest
- NET: net interest income
- NETOP: total income of commercial banks (NETOP = NON + NET)

If net non–interest income is negative, it is considered as $ICO_{NON} = 0\%$, which means that the bank does not use private equity (Ho Thi Hong Minh and Nguyen Thi Canh 2015). Thereby, the higher the ICO_{NON} index, the higher the contribution ratio of non–interest income of banks. The study expects banks to promote and maximize the productivity of non–traditional business activities (ie, the higher the ICO_{NON}), the higher the operational efficiency of commercial banks. **Hypothesis 1: Non–interest income (ICONON) has a positive impact on the operating performance of commercial banks (H_1).**

SIZE – Bank size: Bank size is measured by taking the logarithm of total assets of that bank (Nguyen Minh Kieu 2009). The data are placed in logarithmic form because this is a strong trending feature and it dominates the rest of the components (Pham Thi Tuyet Trinh 2016). Large banks will generate revenues from related services (Elsas et al. 2010; Chiorazzo et al. 2008). **Hypothesis 2: The size of the bank (SIZE) has a positive impact on the operating performance of commercial banks (H_2).**

LOAN – Size of Credit Activity: Measured by taking the ratio of outstanding loans to total assets (Mercieca et al. 2007). This is an indicator showing the impact of lending activities on the bank's business performance (Chiorazzo et al. 2008). Bank profits will increase as loans increase, meaning that banks are focusing on lending rather than paying attention to other activities. **Hypothesis 3: The size of credit activities (LOAN) has a positive impact on the operating performance of commercial banks (H_3).**

EQUITY – Capital Structure: Measured by the ratio of equity to total assets (Abd Karim et al. 2010). Theoretically, a bank's capital ratio is often tied to its own size because large banks tend to generate more profits than small banks due to their less expensive ability to raise capital. Bourke (1989) and Nguyen Tran Thinh (2013) have shown that the higher the capital ratio, the more profitable banks will be. In addition, an increase in the capital ratio can also provide unexpected returns from anticipated cost reductions from economic risks (including bankruptcy) according to Berger's research (1995) and was retested according to the study of Sufian, F. (2011). **Hypothesis 4: Capital structure (EQUITY) has a positive impact on the performance of commercial banks (H_4).**

COST – Operating Expenses: Measured by operating expenses on total assets Obamuyi (2013). This ratio shows the total cost of the bank as a percentage of the total assets. The higher this ratio shows that the bank has not managed its expenses effectively and vice versa, the low this ratio shows that the bank's expenses are well managed, showing the talent and vision of the bank's managers. The higher the cost, the lower the profit. On the contrary, when banks manage costs well, profits will increase significantly. From there, costs will have a negative impact on bank profits. According to Guru et al. (2002); Bourke (1989) argues that the bank that cuts costs and uses management costs effectively, the more efficient it is. **Hypothesis 5: Operating cost (COST) has a negative impact on the performance of commercial banks (H_5).**

DTL – Deposit Size: Measured by customer deposits over total liabilities (Shiers 2002). In which the total liabilities of the bank, the capital from customer deposits is said to be a stable and cheaper source of funding compared to other sources of funding (Ho Thi Hong Minh and Nguyen Thi Canh 2015). Thus, the higher the customer deposit ratio,

the higher the bank's profitability. **Hypothesis 6: Deposit size (DTL) has a positive impact on the performance of commercial banks (H_6).**

LLP – Bank's Asset Quality: Calculated according to the ratio of provision for bad debts to total loans to customers (Berger et al. 2010). This ratio reflects what percentage of the loan balance is provisioned. The higher this index, the higher the quality of the credits of that bank is not good, the debt collection ability is low or vice versa, when this ratio is low, the quality of the credits is improved positively or maybe the provisions are not set up in accordance with regulations. Meanwhile, credit is the most profitable activity for banks, so this factor is expected to negatively affect profitability. Weersainghe and Perera (2013) show that the asset quality of banks has a negative impact on the profitability of banks. **Hypothesis 7: Asset quality (LLP) has a negative impact on the performance of commercial banks (H_7).**

GDP – Economic Growth Rate: The author uses GDP growth rate to control for macroeconomic cycles. The economic growth rate is measured by the nominal GDP growth rate:

$$\text{Economic growth rate} = \frac{GDP_t - GDP_{t-1}}{GDP_{t-1}} \times 100(\%)$$

Source: Delis, M. D. (2012)

In the context of the unstable economy, the Bank will tighten loans, limit lending and reduce deposit interest rates, in addition, increase the provision for credit risks and reduce the bank's profitability. On the contrary, if the economic situation is positive, people's incomes will be stable, so the amount of savings flowing into banks will increase and businesses expand their investment with the need to borrow capital and thereby increase the profitability of banks. Thus, the business cycle affects net profit margin (through lending) and credit risk provision (through loan portfolio quality) (Ho Thi Hong Minh and Nguyen Thi Canh 2015). **Hypothesis 8: Economic growth (GDP) has a positive impact on the operational performance of commercial banks (H_8).**

INF – Inflation Rate: The author uses the consumer price index CPI to measure the inflation rate:

$$\text{Inflationrate} = \frac{P_0 - P_{-1}}{P_{-1}} \times 100(\%)$$

In which:

– P_0: average price level of the current period

– P_{-1}: is the average price level of the previous period

Source: Delis (2012)

Bank as a special enterprise with business goods is currency, so the inflation rate directly affects the profitability of the bank. When inflation decreases, the purchasing power of Vietnam dong increases, at this time the price of gold and foreign currencies will decrease, so banks are convenient in mobilizing capital, lending and performing banking services. When inflation gets out of control, costs will increase, and at some point will destroy the entire economy. Revell (1979) said that the impact of inflation on the bank's business performance depends on the impact of inflation on salary and other operating

expenses of the bank. If the future inflation rate can be accurately forecasted, the bank can easily manage its operating expenses by adjusting the interest rate appropriately so that revenue grows faster than expenses and thereby earns more profit. According to Boyd et al. (2001), there is a significant negative economic relationship between inflation and banking sector development. Chirwa (2003); Syafri (2012); Adama and Apélété (2017); Delis (2012) all believe that the inflation rate has a negative impact on the bank's operational performance. This makes it possible for inflation to contribute to the bank's financial performance and to engage in both interest and non–interest income activities. When the general price of goods increases, the operating costs of banks also increase, leading banks to increase their profit margins to compensate for the increase in operating costs. **Hypothesis 9: Inflation (INF) has a negative impact on the performance of commercial banks (H_9)** (Table 1)**.**

3.3 Research Methods

Since most prior research was performed using a frequency approach, a priori information is not available. However, since the number of observations in the sample of 300 observations is relatively large, the priori information does not affect the posterior distribution too much. In this case, Block et al. (2011) proposed a standard Gaussian distribution with different a priori information (simulation of a priori information) and carried out Bayesian factor analysis to choose a simulation with the best priori news.

The simulations in Table 2 show decreasing levels of a priori information with Simulation 1 having the strongest priori information and Simulation 5 having the weakest priori information.

Similar to model 2, we also build 5 simulations (from simulation 6 to simulation 10) with simulation 6 having the strongest a priori information ($\beta_i \sim N(0, 1)$ and model 10 having the strongest a priori information. Weakest a priori information ($\beta_i \sim N(0, 10000)$.

In the next step, the research team carried out Bayesian regression for the above simulations, then performed Bayesian factor analysis (Bayes Factors) and Bayes test model (bayestest model). These are the techniques proposed by StataCorp LLC (2019) to select the simulation with the best a priori information. Basically, the Bayesian factor will provide a tool to compare the probability of a particular hypothesis (a priori information) to the probability of another hypothesis. It can be understood as a measure of the strength of evidence in favor of a theory among competing (information a priori) theories. Accordingly, Bayesian analysis will provide average Log BF (Bayes Factor – Bayesian factor), Log ML (Marginal Likelihood – marginal likelihood) and average DIC (Deviance Information Criterion – information bias); The posterior Bayesian test will help compare the posterior probability of the simulations with different a priori information, accordingly, based on the research data combined with the proposed a priori information, we will choose The simulation has the largest posterior probability P(M|y).

In summary, in this study, the research team will build 5 simulations with 5 different a priori information, and Bayesian factor analysis and posterior Bayes test will help to choose a simulation with suitable a priori information. The simulation selected will be the one with the largest Log BF, Log ML average, minimum DIC mean and the largest P(M|y).

Table 1. Expected signs of variables in the research model

Variable	Expected signs	Previous studies
Dependent variable		
ROA		Ho Thi Hong Minh and Nguyen Thi Canh (2015); Trujillo–Ponce (2013); Vincenzo Chiorazzo et al. (2008); Som Raj Nepali (2018); Le Long Hau and Pham Xuan Quynh (2017), Nguyen Minh Sang and Nguyen Thi Thuy Trang (2018)
Group of bank characteristics		
ICO_{NON}	+	Apergis (2014); Saunders et al. (2014), Le Long Hau and Pham Xuan Quynh (2017), Nguyen Minh Sang and Nguyen Thi Thuy Trang (2018)
SIZE	+	Stiroh and Rumble (2006); DeYoung and Rice (2004b), Chiorazzo et al. (2008); Bourke, P. (1989); Adama and Apélété, T. (2017); Syafri (2012)
LOAN	+	Mercieca, Schaeck, and Wolfe (2007); Stiroh and Rumble (2006); Chiorazzo and authors (2008)
EQUITY	+	Abd Karim et al. (2010); Mercieca, Schaeck, and Wolfe (2007); Stiroh and Rumble (2006); Chiorazzo et al. (2008); Bourke (1989); Nguyen Tran Thinh (2013); Berger (1995)
COST	–	Bourke (1989); Guru et al. (2002); Syafri (2012)
DTL	+	Shiers (2002); Le Long Hau and Pham Xuan Quynh (2017); Ho Thi Hong Minh and Nguyen Thi Canh (2015)
LLP	–	Weersainghe and Perera (2013); Sufian and Habibullah (2009); Ahmad (2014); Nguyen Thanh Phong (2015)
Macro variables		
GDP	+	Obamuyi (2003); Adama and Apélété (2017); Chirwa (2003), Delis (2012)
INF	–	Chirwa (2003); Syafri (2012); Adama and Apélété (2017); Revell (1979), Delis (2012)

Source: Compiled by the author.

4 Results and Discussion

In Bayes Factor analysis, the selected model will be the one with the highest Log(BF), Log(ML) and the smallest DIC. The results in Table 3 show that model 1 with simulation 3 has the most advantage when Log (BF) and Log (ML) are the highest, however DIC is not as good as model 4 and 5. To ensure there is To be able to choose the most appropriate a priori information, the authors continue to analyze the Bayes test model, the results show that simulation 3 is the best when the P (Mly) criterion is superior to the other models remaining burn.

Bayesian analysis is simulated through the Markov Chain Monte Carlo (MCMC), therefore, to ensure the stability of the Bayesian regression, the MCMC series must

Table 2. Simulation of a priori information

Rational function	$ROA \sim N(\mu, \sigma)$
A priori distribution	
Simulation 1	$\alpha \sim N(0, 1)$ $\sigma^2 \sim Invgamma(0.01, 0.01)$
Simulation 2	$\alpha \sim N(0, 10)$ $\sigma^2 \sim Invgamma(0.01, 0.01)$
Simulation 3	$\alpha \sim N(0, 100)$ $\sigma^2 \sim Invgamma(0.01, 0.01)$
Simulation 4	$\alpha \sim N(0, 1000)$ $\sigma^2 \sim Invgamma(0.01, 0.01)$
Simulation 5	$\alpha \sim N(0, 10000)$ $\sigma^2 \sim Invgamma(0.01, 0.01)$

Source: Compiled by the author.

Table 3. Bayes Factor Analysis Results

	Chains	Avg DIC	Avg log (ML)	Log (BF)	P (M|y)
Simulation1	3	481.1574	–271.5035		0.000
Simulation2	3	445.5263	–258.7603	12.743	0.371
Simulation3	3	430.2282	–258.2345	13.269	0.628
Simulation4	3	427.6046	–265.2892	6.2143	0.001
Simulation5	3	427.6478	–276.0932	–4.589	0.000

Source: Compiled by the author.

converge, which means that the MCMC series must ensure stationarity. StataCorp LLC (2019) proposes that the MCMC series convergence test can be conducted through the convergence diagnostic graph.

According to StataCorp LLC (2019), the MCMC series convergence diagnostic graph includes trace plot, histogram, autocorrelation, and density plot. The trace plot helps to track the historical display of a parameter value over the iterations of the series, Fig. 1 shows the trace plot fluctuates around the mean value, so the MCMC series is stationary, that is, reaching convergence conditions. Besides, the autocorrelation chart in the graphs only fluctuates around the level below 0.02, according to StataCorp LLC (2019) the autocorrelation chart fluctuates around the level below 0.02, showing the agreement with the density the distribution and reflect all delays that are within the effective limit. According to StataCorp LLC (2019), the posterior distribution plot and density estimate show that the simulation of the shape of the normal distribution of the parameters, the histogram shape is uniform, it can be concluded that Bayes regression

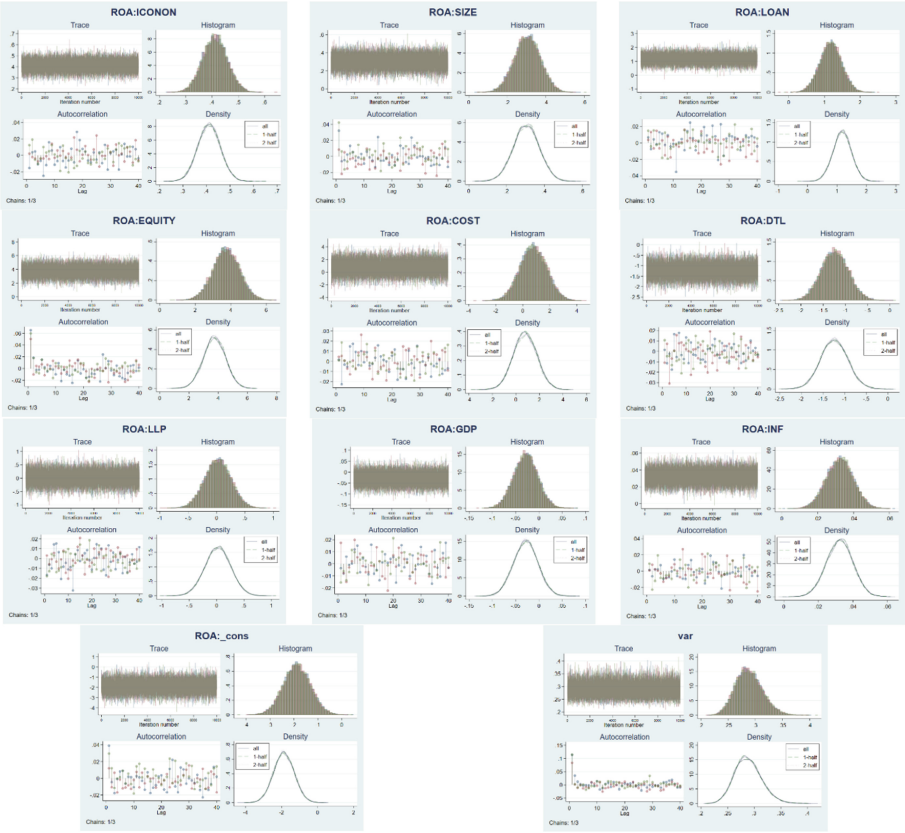

Fig. 1. Convergence diagnostic graph Source: Calculations of the author

ensure stability. Thus, the results from Fig. 1 show that the MCMC series meets the convergence condition.

In addition to graphical convergence diagnostics, StataCorp LLC (2019) also recommends testing through Mean Acceptance Rate; Average minimum efficiency; and Gelman–Rubin Rc max. Table 4 shows that the model's acceptance rate reaches 1, the model's minimum efficiency is 0.912, far exceeding the allowable level of 0.01; In addition, the maximum Rc value of the coefficients is 1, Gelman and Rubin (1992) argue that the diagnostic value Rc of any coefficient of the model greater than 1.2 will be considered non–convergent. Thus, the values in Table 4 show that the MCMC series of the model satisfy the convergence requirements.

The regression results in Table 4 have determined that the variables DTL and GDP have a negative impact on ROA and the remaining variables help to improve ROA. Meanwhile, for the ROE variable, EQUITY, DTL, LPP and GDP have a negative effect while the variables ICO_{NON}, SIZE, LOAN and INF have a positive effect on ROE. Besides determining the sign of the regression coefficients, unlike the frequency method,

Table 4. Regression results

	Mean	Std. Dev	MCSE	Median	Equal–tailed	
					[95% Cred. Interval]	
ICONON	0.412	0.047	0.000	0.412	0.320	0.504
SIZE	0.304	0.068	0.000	0.305	0.170	0.436
LOAN	1.179	0.312	0.002	1.180	0.559	1.794
EQUITY	3.744	0.752	0.005	3.750	2.278	5.215
COST	0.787	0.996	0.006	0.787	–0.967	2.742
DTL	–1.240	0.311	0.002	–1.241	–1.853	–0.625
LLP	0.020	0.237	0.001	0.021	–0.444	0.482
GDP	–0.029	0.026	0.000	–0.029	–0.080	0.023
INF	0.032	0.008	0.000	0.032	0.017	0.047
_cons	–1.875	0.574	0.003	–1.881	–2.997	–0.737
var	0.288	0.025	0.000	0.287	0.244	0.342
Avg acceptance rate	1.000					
Avg efficiency min	0.811					
Max Gelman–Rubin Rc	1.000					

Source: Calculations of the author.

the Bayesian approach also allows us to calculate the probability of the occurrence of these effects (Table 5).

Table 5. Probabilistic test

ROA			
prob {ROA:ICONON} > 0	1.000	0.000	0.000
prob {ROA:SIZE} > 0	1.000	0.006	0.000
prob {ROA:LOAN} > 0	1.000	0.008	0.000
prob {ROA:EQUITY} > 0	1.000	0.000	0.000
prob {ROA:COST} > 0	0.896	0.410	0.002
prob {ROA:DTL} < 0	1.000	0.006	0.000
prob {ROA:LLP} > 0	0.536	0.499	0.003
prob {ROA:GDP} < 0	0.764	0.343	0.002
prob {ROA:INF} > 0	1.000	0.000	0.000

Source: Calculations of the author.

The variables ICO_{NON}, SIZE, LOAN, EQUITY, DTL, INF have a positive impact on the operational performance of banks (ROA) very clearly when the impact of these variables on ROA has a probability of touching 100%; The COST variable also tends to have a strong supportive effect on ROA when its probability of impact is approximately 90%. The variables LLP, GDP have a relatively weak impact on ROA when the overall probability is only 54% and 76%, respectively (Table 6).

Table 6. Comparison of expected results and research results of SMALL characteristic variables

Variable	Expectation	Result
ICO_{NON}	+	+
SIZE	+	+
LOAN	+	+
EQUITY	+	+
COST	–	+
DTL	+ /–	+
LLP	–	The impact is not clear

Source: Compiled of author
Note: + is the positive effect, – is the opposite effect

Bank Size (SIZE): The estimated results show that SIZE has a positive effect on ROA means that an increase in bank size will increase the bank's operational efficiency. This result coincides with the author's expectation. In previous empirical studies, this result is also consistent with the research results of authors such as Stiroh and Rumble (2006); DeYoung and Rice (2004b), Chiorazzo et al. (2008); Bourke (1989); Adama and Apélété (2017); Syafri (2012), etc. Vietnamese commercial banks with large scale and wide branches will have an advantage in capital mobilization, product and service development, and accessibility to customers. Higher banks, especially the competitiveness of large–scale banks will be stronger than those of small–sized banks, expanding the transaction network to central/populous areas to increase the number of customers. Therefore, an increase in bank size will increase profitability. In order to maximize the effectiveness of the network expansion and scale, commercial banks need to have specific plans to increase capital as well as improve the quality of products and services of the bank, thereby bringing benefits. Profits for commercial banks.

Credit Size (LOAN): The estimated results show that credit size has a positive impact on ROA. This result also coincides with previous empirical studies such as those of Mercieca, Schaeck, and Wolfe (2007); Stiroh and Rumble (2006); Chiorazzo et al. (2008). The research results reflect the reality of commercial banks in Vietnam that banks focus on lending to increase interest income and good loan quality will contribute to increasing bank profits. The bank's 3 main activities include providing credit, mobilizing deposits and performing payment intermediary functions. In particular, lending activities inherently account for a high proportion of income generation for banks. Therefore, when the

bank's lending rate increases, it will bring about a high rate of interest income (earnings from the difference between lending interest rates and deposit rates), thereby increasing the bank's profits.

Equity Structure (EQUITY): The estimation results show that capital structure has a positive effect on ROA. This result also coincides with previous experimental studies such as that of Abd Karim et al. (2010); Mercieca, Schaeck, and Wolfe (2007); Stiroh and Rumble (2006); Chiorazzo et al. (2008); Bourke (1989); Nguyen Tran Thinh (2013); Berger (1995). The increase in capital not only gives commercial banks the opportunity to expand credit, diversify products and services, improve financial capacity, and ensure financial ratios, but also protect customers. When the bank encounters risk during its operation, it helps the commercial bank to create a reputation among customers and investors. When the bank's financial capacity is improved, it will avoid wasting capital, save capital mobilization costs, and operate more effectively, so profitability will increase. When the equity ratio is high, the bank has a lower level of risk. Accordingly, banks with high capital ratios considered safer will be able to generate more profits. In addition, banks with a higher equity level often reduce the need for external capital, limiting the volatility of interest expenses, thereby positively affecting the bank's performance.

Operating Cost (COST): The estimated results show that capital structure has a positive impact on ROA. This does not coincide with the author's previous expectation, as well as the previous research results such as the study of Bourke (1989); Guru, Staunton, and Balashanmugam (2002); Syafri (2012). This can be explained that when banks begin to focus on increasing non–interest income ratio, increasing equity, investing in technology development, expanding branch network, transaction office services and increasing human resources to attract customers will incur additional operating costs. Thus, in case the bank's revenue increases, the higher the cost, the higher the profit of the bank will be.

Deposit Size (DTL): The estimated results show that deposit size has a positive effect on ROA. This result is consistent with studies of Shiers (2002); Le Long Hau and Pham Xuan Quynh (2017); Ho Thi Hong Minh and Nguyen Thi Canh (2015). Deposits are the main source of capital, accounting for a large proportion of mobilized capital in particular and business capital of commercial banks in general. The larger the deposit size, the greater the bank's ability to use capital, the more capital the bank has to finance lending activities, contributing to making the bank profitable. In fact, banks are currently competing with each other on deposit rates to attract depositors.

Asset Quality (LLP): Estimation results show that asset quality has no impact on ROA. This does not coincide with the author's previous expectations, as well as the results of previous studies such as that of Weersainghe and Perera (2013); Sufian and Habibullah (2009); Ahmad (2014); Nguyen Thanh Phong (2015). In other words, hypothesis H_7 is rejected.

GDP Growth Rate (GROWTH): The estimated results show that economic growth tends to have a negative impact on ROA. This does not coincide with the previous expectations of the author, as well as the results of previous studies such as the study of Obamuyi (2003); Adama and Apélété (2017); Chirwa (2003), Delis (2012).

Inflation (INF): The estimated results show that inflation has a positive impact on ROA with the probability of impact reaching the threshold of 100%. This does not coincide with the author's previous expectations, as well as the results of previous studies such as that of Chirwa (2003); Syafri (2012); Adama and Apélété (2017); Revell (1979), Delis (2012). This can be explained that when the inflation rate is high, commercial banks in Vietnam have policies to adjust interest rates accordingly raised in a timely manner, causing the difference between lending rates and deposit rates to increase, which will help increase the bank's profit. In addition, rising inflation reduces the real income of customers, thereby stimulating their investment and savings, so it will be easier for banks to raise capital with lower mobilization costs, help improve bank profitability.

5 Conclusion

5.1 Conclusion

Through significant statistical values with a confidence level of up to 99%, it can be affirmed that: developing in the direction of increasing the proportion of non–interest income generating activities will help commercial banks increase operational efficiency.

There are 07 factors that have a positive impact on the performance of Vietnamese commercial banks, including 06 internal factors which are non–interest income (ICONON), the size of the bank (SIZE), the size of the credit operation (LOAN), the capital structure (EQUITY), the operating cost (COST), the size of the deposit (DTL), and one external factor, in addition to the inflation rate (INF). Variables asset quality of banks (LLP) and economic growth rate (GDP) are not statistically significant.

5.2 Recommendations

First, *improving sales policies/models and diversifying products/services to improve service quality for customers*: Because they often have to face the constant competition of commercial banks, with both domestic and foreign trade, with the increasingly diverse needs and expectations of customers and the development of today's technology, the research into new products/services is indispensable in the operations of banks. Increasing the development of products such as cards, bond issuance, retail banking services, e–banking, etc. to create a distinction from your bank.

Second, *transfer some basic needs of existing customers to Kiosk Selfservices/Live Bank to reduce the load on the counter.* Currently on the market, there are only 3 banks that put the automatic banking system into operation, that is VP bank with VPBank NEO Express; TP Bank with Tien Phong Live Bank and Nam A Bank with Nam A OneBank digital ecosystem. Commercial banks need to build self–service transaction points (kiosk selfservices), which can provide most of the bank's products/services like traditional branches/transaction offices, but fully automated by modern machinery and technology. Accordingly, it is necessary to understand the customer's daily life journey, find out the customer's financial transaction needs such as frequency of use, when to use, how to choose a transaction location/method, etc.… Analyze customer's dissatisfaction/pain points during transaction at branch/transaction office, thereby assessing customer's need

to use selfservices/Live Bank kiosk and record customer's evaluations and suggestions for the Kiosk Selfservices/Live Bank model.

Third, *provide solutions to develop modern banking services, depending on each customer (individuals or businesses) to offer appropriate services.* Banks should encourage customers to use SMS banking, mobile app, internet banking, integrate QR payment on internet banking, link payment via e–wallets like Momo, Airpay, Moca, etc. non–cash payment method, encouraging customers to use the card by implementing attractive promotions (for example, the top 10 Visa cardholders with the highest total payment value of the week will receive 1 coupon code lucky to participate in the lucky draw program). This is also completely consistent with the development trend and orientation of commercial banks in Vietnam today, namely promoting banking activities in the direction of modernity and digital technology, similar to the orientation of Vietnam's commercial banks. Decision No. 1813/QD–TTg on the approval of the Project on development of non–cash payments in Vietnam for the period of 2021–2025 issued by the Prime Minister of Vietnam on October 28, 2021.

Fourth, *increase non–interest income from commissions and fees by promoting cross–selling of products and services to existing customers*, stimulating demand and selling more products and services that customers have not used, especially focus on exploiting the group of customers who have loans at the bank.

Fifth, *regularly train human resources.* Since non–profit activities often use modern technology, employees must be knowledgeable and able to use technology proficiently. Commercial banks need to regularly organize training courses to improve their professional skills as well as how to use new banking technology to improve the professional qualifications of their staff. High–quality human resources will help the bank bring products/services to customers more easily and conveniently, increasing customer satisfaction and willingness to recommend the bank to relatives, friends, colleagues. In addition, it is necessary to pay attention to the quality of governance and internal inspection and control. This work must be regularly updated and upgraded in parallel with the development of technology. In addition, banks also need to improve the image, customer service and professionalism of their staff so that customers have the best experience when using the bank's products and services, thereby building a strong brand, reputation to gain trust from customers.

Sixth, *there is a specific strategy to develop non–interest income*: Although non–interest income has a positive impact on the performance of commercial banks, credit and savings are still the main activities of commercial banks. Therefore, commercial banks need to build the most appropriate, optimal ratio of non–interest income to total income in the direction of decreasing dependence on traditional activities. Specifically, in the structure of non–interest income, the bank should have a ratio for each type such as income from services; income from business, investment, etc. to have reasonable promotion solutions.

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