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Financial crisis and diversification strategies:
The impact on bank risk, and performance

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Abstract

This paper explores the impacts of asset, funding, and income diversification strategies and their combinations on the banking system's performance and risk in Vietnam. Dynamic models, using two-step difference-GMM with panel data collected from 34 Vietnamese commercial banks from 2005 to 2019, are employed. Results indicate that, in general, diversification practices in banking sectors are effective in improving banks' risk-return profile, especially during the Vietnamese banking crisis from 2011 to 2014. However, using them in combinations is only effective for income and funding diversifications. These results are robust regarding the use of alternative measures of diversification level. Based on the findings, managers and government agencies in the Vietnamese banking sectors could be informed about the diversification strategy effectiveness to aid their strategic decisions on operations, investments, and financing.

Keywords: bank diversification; bank performance; bank risk; financial crisis; GMM; Vietnam
JEL Classification Codes: G01, G21

1. Introduction

The practice of diversification has created conflicting arguments about its impact on the banking sector's risk and performance. On the one hand, a diversification strategy is motivated by certain advantages that focused banks cannot have: (1) gaining from exploiting managerial skills and abilities across products and geographical areas (Iskandar-Datta & McLaughlin, 2007), (2) taking advantage of economies of scale by sharing fixed costs across various products and markets (Drucker & Puri, 2009), and (3) offering a wide range of financial services to clients who require multiple products.

On the other hand, the ones that prefer the concentration strategy claim that diversified banks can reduce their comparative management advantage when investing in many areas they are not experts (Klein & Saidenberg, 1998). Furthermore, diversification increases competition (Winton, 1999) and creates higher agency costs resulting from diminishing value activities when managers want to reduce their risk (Laeven & Levine, 2007).

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The empirical literature on banking diversification first addresses developed markets, where banks have been fully mature, such as the US market and other developed countries in Europe (Curi, Lozano-Vivas, & Zelenyuk, 2015; Elsas, Hackethal, & Holzhäuser, 2010; Mercieca, Schaeck, & Wolfe, 2007; Stiroh & Rumble, 2006). The research and discussion on this topic in emerging and transition economies are explored (Chen, Liang, & Yu, 2018; Moudud-Ul-Huq, Ashraf, Gupta, & Zheng, 2018). However, the literature provides different results for different countries and regions (T. L. A. Nguyen, 2018). According to (Doumpos, Gaganis, & Pasiouras, 2016), diversification can be more beneficial for banks operating in less developed countries compared to banks in advanced and major advanced countries.

The Vietnamese banking system is currently undergoing significant reforms since the banking crisis from 2011 to 2014 (Huynh, Nasir, Nguyen, & Duong, 2020; D. P. Nguyen, Ho, & Vo, 2018). After the Global Financial Crisis (GFC) in 2008–2009 of economic stimulus measures, the rapid credit expansion created the asset-quality problem for most Vietnamese commercial banks. It was the underlying cause of the recent banking crisis in Vietnam. Academic studies have found evidence that diversification decreases risk and that concentration, in contrast, is a common reason for the banking crisis (Markowitz, 1959). Due to the bank's credit portfolio's concentration risk during this credit boom period, the Vietnamese banking system's contagion risk is also considerably concerned. As a result, the average non-performing loans to total bank capital in the banking system spiked from under 5% in 2011 to nearly 12% in 2012 and about 15% in 2014, according to Fitch Ratings and Moody's Investor service estimations (ADB, 2014). Since then, Vietnamese commercial banks started to reconstruct their assets, liabilities, and income quality.

On the one hand, commercial banks started to divest from different non-core business activities as presented by the decreasing trend in the asset diversification index from 2011 to 2019 (see Figure 1). On the other hand, Vietnamese banks increasingly employed diversification strategies for funding sources and income generations (see Figure 1). These arising and contrasting trends raise an interesting research question: whether diversification strategies effectively affect the Vietnamese banking system performance and risk, especially in the banking crisis period? More importantly, in practice, banks need to deal with all three diversification strategies simultaneously. Thus, it is interesting to investigate how banks can combine these three diversification strategies to achieve their expected risk-return objectives. This paper explores these two research questions using unique banking data in Vietnam.

Figure 1. Diversification indexes of the Vietnamese banking system from 2005 to 2019.
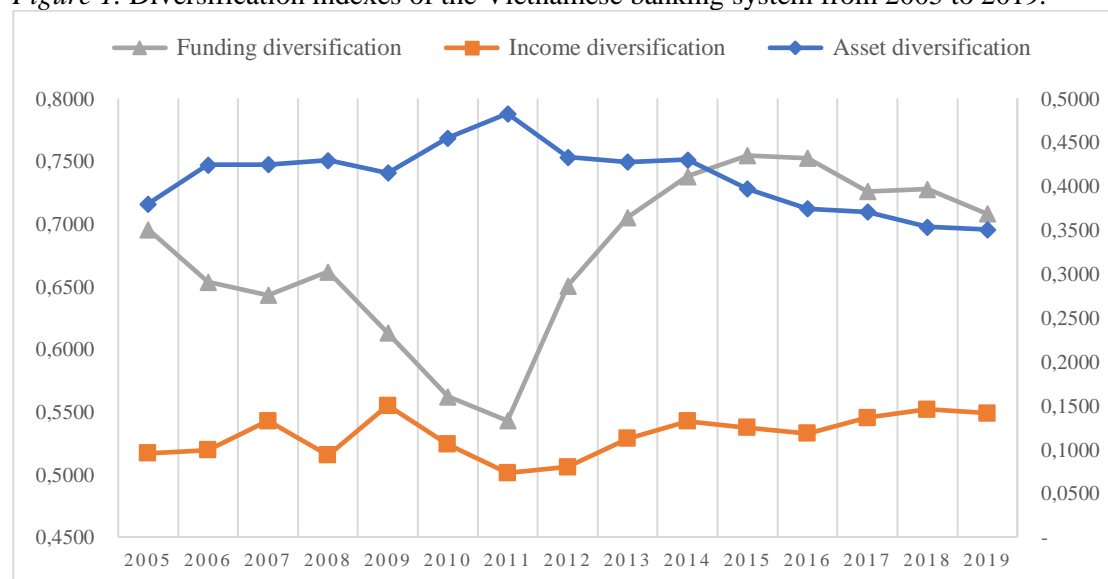
Source: own calculation.

2. Data and methodology

2.1. Data

This research uses a dynamic panel data sample from 34 Vietnamese banks from 2005 to 2019. The sample data are mainly collected from Bankscope. The author only chooses banks that are still in operation until 2019, banks being merged or acquired during banking and financial crisis are eliminated from the sample. Further, some banks do not show their asset components in the financial statement, so that the asset diversification index is missing for some years. Finally, this study uses an unbalanced panel data of 34 commercial banks in 15 years, with a total of 406 bank-year observations.

The main explanatory variables are the degree of diversification, constructed by subtracting HHI from 1 to increase with diversification (Curi et al., 2015; Elsas et al., 2010). We calculated the diversification indexes for assets, liabilities (funding), and the banks' income sides[1].

The dependent variables in our estimation model are bank risk and performance measures. Following recent literature (Amidu & Wolfe, 2013; Vo, 2018), the study uses bank returns on assets (ROA) and return on equity (ROE).

This study employs three inverse bank risk indicators that are widely used in banking studies (Amidu & Wolfe, 2013; Vo, 2018). The first two risk proxies are the standard deviation of ROA (SDROA) and the standard deviation of ROE (SDROE) over three-year rolling windows. Higher values of SDROA and SDROE represent higher bank income risk. Our third proxy is a measure of the default risk of each bank by computing the ZSCORE[2]. Lower values of ZSCORE denote a higher risk and higher probability of default.

We also include in the regressions a set of variables to control for bank heterogeneities that can affect bank risk-taking and performance in addition to diversification (Edirisuriya, Gunasekarage, & Dempsey, 2015; Meslier, Tacneng, & Tarazi, 2014; Sanya & Wolfe, 2011; Stiroh & Rumble, 2006): the natural logarithm of bank total assets to account for bank size (LNASSET); the ratio of equity to total assets (ETA) to control for bank capitalization; the ratio of loans loss provision (LLP); crisis dummy variable to account for the financial crisis period 2011–2014; and finally the inflation rate (INF) and the growth rate of the real gross domestic product (GDP) to take into account differences in the macroeconomic environment.

Accounting for the effects of the financial crisis on the nexus between diversification, bank risk, and performance, the study uses interactive variables between diversification and financial crisis (Luu, Nguyen, & Vu, 2019). The interactive variables of different diversification strategies are also created for exploring how effective the combined strategies are in the banking system.

2.2. Methodology

Using the two-step difference Generalized Method of Moments estimation method (difference-GMM) as suggested by Arellano and Bover (1995); Blundell and Bond (1998) for dealing with panel data with a relatively large number of cross-sectional data compared to a relatively short time. Furthermore, because the diversification indexes are measured indirectly using proxies (see Appendix 1), measurement errors are a major concern that can cause endogeneity problems in regression models. Thus, the two-step difference-GMM could address these issues and estimate the following three equations:

$$Y_{i,t} = \alpha + \beta_1 Diversification_{i,t} + \beta_2 Control_{i,t} + \varepsilon_{i,t} \qquad (1)$$

$$Y_{i,t} = \alpha + \beta_1 Diversification_{i,t} + \beta_2 Control_{i,t} + \beta_3 Crisis_{i,t} + \beta_4 CrisisxDiversification_{i,t} + \varepsilon_{i,t} \qquad (2)$$

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[1] Detailed measurements of diversification indexes are shown in Appendix 1.
[2] Detailed formular of bank risk indicators are shown in Appendix 2.

Table 1. Descriptive statistics.

Dependent variables	Obs	Mean	Std. Dev.	Min	Max
Bank ID	406	17.93842	10.02016	1	34
Year	406	2012.786	3.853604	2005	2019
Bank performance					
Return on asset (ROA)	403	0.01014	0.009654	-0.05993	0.06403
Return on equity (ROE)	403	0.104266	0.096353	-0.56326	0.693914
Bank risk					
Standard deviation of ROA (SDROA)	404	0.00456	0.005735	3.21E-05	0.043431
Standard deviation of ROE (SDROE)	404	0.039833	0.04421	0.000676	0.372636
Insolvency risk (ZSCORE)	403	18.22535	12.05709	0.335232	95.99393
Independent variables					
Diversification indexes					
Asset diversification (AD)	375	0.498402	0.119095	0.123916	0.676475
Income diversification (ID)	404	0.172708	0.123104	-0.13986	0.548667
Funding diversification (FD)	404	0.491593	0.131485	0.108656	0.755861
Interaction terms between diversification strategies					
Asset and income (ADxID)	406	0.082345	0.071288	-0.04802	0.316548
Income and funding (IDxFD)	406	0.083051	0.064606	-0.07486	0.396726
Funding and asset (FDxAD)	406	0.231353	0.117366	0	0.479877
Asset, income and funding (ADxIDxFD)	406	0.040121	0.036285	-0.02722	0.175395
Interaction terms between diversification and crisis					
Financial crisis (CRISIS)	406	0.317734	0.46617	0	1
Asset diversification and Crisis (ADxCRI)	406	0.157647	0.250019	0	0.676475
Income diversification and Crisis (IDxCRI)	406	0.045371	0.095786	-0.12768	0.463259
Funding diversification and Crisis (FDxCRI)	406	0.163963	0.25114	0	0.755861
Control variables					
Equity to asset ratio (ETA)	404	0.116745	0.106908	0.004061	0.942857
Logarithm of total asset (LNASSET)	404	18.01088	1.316596	13.88913	20.97204
Loan loss provision (LLP)	395	0.01289	0.006082	0.000129	0.037018
Annual growth of GDP (GDP)	406	0.062686	0.006605	0.052474	0.075473
Annual consumer price index (INF)	406	0.075327	0.059196	0.008786	0.231163

$$Y_{i,t} = \alpha + \beta_1 Diversification_{i,t} + \beta_2 Control_{i,t} + \beta_4 Interactive\ Diversification_{i,t} + \varepsilon_{i,t} \tag{3}$$

where Y denotes dependent variables measure bank risk and performance, which can be either ROA, ROE, SDROA, SDROE, or ZSCORE; i and t identify individual banks in the sample and time variable in years; α is the coefficient; βs are the parameters to be estimated; Diversification is either asset, funding, or income diversification strategies; Control is a matrix of bank-specific control variables and macroeconomic indicators; Crisis is dummy variables indicates the Vietnamese banking crisis period 2011–2014; CrisisxDiversification is interactive variables between diversification indexes and banking crisis; Diversification Combination is interactive variables between the three diversification indexes.

3. Results and discussion

3.1. Descriptive statistics

Table 1 presents the descriptive statistics of variables. Among the three diversification indexes, the asset and funding diversification are similar (means = 0.49). The income diversification index is much smaller (mean = 0.172). Table 2 shows the correlation matrix between variables.

Table 2. Cross-correlation matrix of variables.

	ROA	ROE	SDROA	SDROE	ZSCORE	AD	ID
ROA	1						
ROE	0.6356*	1					
SDROA	0.1704*	-0.1146*	1				
SDROE	-0.07	0.0679	0.6119*	1			
ZSCORE	0.1599*	-0.1136*	0.0703	-0.1719*	1		
AD	0.052	-0.0503	-0.0168	-0.1336*	0.1453*	1	
ID	0.3926*	0.2268*	0.0369	0.0418	0.2385*	0.1865*	1
FD	0.1769*	0.022	0.0516	-0.0308	0.2119*	0.3394*	-0.079
ETA	0.2736*	-0.1976*	0.5952*	-0.0466	0.4082*	0.0305	0.0138
LNASSET	-0.1463*	0.2637*	-0.4069*	0.0531	-0.2677*	-0.0429	0.0956
LLP	-0.1785*	-0.1059*	-0.0047	0.1807*	0.0246	0.0882	0.1375*
GDP	0.0001	0.1637*	-0.1767*	-0.1360*	-0.0997*	-0.1144*	0.1206*
INF	0.2124*	0.1046*	0.2033*	0.1536*	0.1094*	-0.0093	-0.1389*
	FD	ETA	LNASSET	LLP	GDP		
FD	1						
ETA	0.0503	1					
LNASSET	-0.3095*	-0.5958*	1				
LLP	-0.1311*	-0.0818	0.2986*	1			
GDP	-0.2059*	-0.1368*	0.1221*	-0.2048*	1		
INF	0.3471*	0.1311*	-0.2775*	-0.069	-0.3386		

Note: ROA & ROE are the return on average assets & equity, respectively; SDROA & SDROE are the standard deviation of return on assets & equity, respectively; ZSCORE is the bankruptcy risk. AD, ID & FD are asset, income & funding diversification, respectively. ADxCRI, IDxCRI, FDxCRI are interactions between asset, income & funding diversification and financial crisis. ETA is the Equity ratio; LNASSET is Logarithm total asset; LLP is Loan Loss Provision; GDP & INFLATION are macroeconomic factors. Standard errors in parentheses. * p < 0.10, ** p < 0.05, *** p < 0.01.

3.2. Diversification strategies, bank performance, and risk

Table 3 represented the base model of each diversification strategy's impact on a bank's performances and risks. The results show that asset diversification does not significantly impact either bank return and risk. Asset diversification does not benefit the bank's performance as banks invest in the external industry and hold non-core assets. One possible reason is the underdeveloped stock market with a market capitalization of 26.8% of Vietnam's GDP. Hence, banks cannot find profitable investment portfolios in equity markets or non-interest-bearing assets to diversify (Moudud-Ul-Huq et al., 2018).

Besides, income diversification, on the other hand, significantly positively impacts profitability. The more other sources of income apart from lending, the more the bank's profits. The findings generally support the concept of economies of scope that claims diversified banks utilize redundant resources and customer base (Luu et al., 2019; Sanya & Wolfe, 2011). Even though income diversification also slightly increases bank returns fluctuation, banks enjoy much lower bankruptcy risk.

Banks with higher funding diversification or lower customer deposits will also make remarkable increases in the bank's profitability. As can be seen in Table 3, the funding diversification is significantly positive with bank performance and reduce bankruptcy risk at the same time. This result is in line with previous findings on the role of bank funding diversity in Vietnam (Batten & Vo, 2016; Vo, 2018). This is the most effective diversification strategy.

3.3 Diversification strategies, bank performance, and risk during banking and financial crisis

Table 4 presents the results of the banking crisis model. During the financial crisis, asset diversification shows a positive relationship with bank return and slightly increases risk. Meanwhile, funding diversity adversely affects bank returns during the financial crisis. High

Table 3. Empirical results – The base model of the effectiveness of diversification strategies on banks performance and risks.

Panel A: Diversification strategies and bank performance

	(1) ROE	(2) ROE	(3) ROE	(4) ROA	(5) ROA	(6) ROA
AD	0.084*			0.010		
	(0.048)			(0.006)		
ID		0.230***			0.035***	
		(0.056)			(0.005)	
FD			0.341***			0.025***
			(0.055)			(0.006)
_cons	-0.463***	-0.280***	-0.736***	-0.027**	-0.020**	-0.055***
	(0.076)	(0.083)	(0.113)	(0.013)	(0.008)	(0.011)
No. of Obs	365	393	393	365	393	393
AR (1)	0.083	0.045	0.135	0.109	0.051	0.043
AR (2)	0.146	0.109	0.117	0.108	0.138	0.144
Hansen test	0.183	0.132	0.197	0.156	0.104	0.170

Panel B: Diversification strategies and bank risk

	(1) SDROE	(2) SDROE	(3) SDROE	(4) SDROA	(5) SDROA	(6) SDROA	(7) ZSCORE	(8) ZSCORE	(9) ZSCORE
AD	-0.040			0.000			4.012		
	(0.033)			(0.003)			(2.858)		
ID		0.088***			0.010***			6.825***	
		(0.022)			(0.002)			(1.479)	
FD			-0.033			0.002			13.505***
			(0.035)			(0.002)			(4.653)
_cons	0.106***	0.079**	0.085	0.015***	0.017***	0.013*	-0.820	18.469**	-4.448
	(0.032)	(0.031)	(0.068)	(0.005)	(0.006)	(0.007)	(8.261)	(7.374)	(10.399)
N	365	393	393	365	393	393	365	393	393
AR (1)	0.002	0.001	0.000	0.143	0.079	0.108	0.141	0.513	0.327
AR (2)	0.193	0.107	0.260	0.592	0.676	0.526	0.813	0.848	0.854
Hansen test	0.153	0.201	0.232	0.198	0.174	0.226	0.259	0.161	0.417

Note: This table shows regression results between bank diversification (DIV) indexes, risk and return. The sample includes 34 banks in Vietnam, over the period 2005-2019. The dependent variables are returns on assets and returns on equity (ROA, ROE), the standard deviation of returns (SDROA, SDROE), and bankruptcy risk (ZSCORE). Key explanatory variables are diversification indexes: Asset (AD), Income (ID), Funding (FD) diversities. Control variables, not shown in this table, include the Equity to Total Asset ratio (ETA), Logarithm of total assets (LNASSET), Loan loss provision (LLP), and macroeconomic factors (GDP and INF). Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

funding diversity means high non-deposit funds, e.g., loans from other banks or issuing bonds. During economic downturns with high inflation, non-deposit funds tend to fluctuate and volatile, with high cost, due to high-interest rates.

In correlation with bankruptcy risks, funding diversity also reduces bankruptcy risks in crisis periods, explained by the diversified funding sources rescue banks from bank-run risk, especially during the crisis. The outcomes are in line with previous studies and confirm funding that diversified banks have advantages in improving profitability without increasing their risk-taking (Vo, 2018). The result has strong implications for bank managers and prudential authorities in emerging markets.

Consistently, in crisis times, income diversification significantly positively impacts bank returns. During the crisis, banks struggle to operate their core business as credit intermediaries due to macroeconomic fluctuations such as a decline in GDP growth and high inflation, leading to difficulties for enterprises repaying bank loans. Hence, banks' lending activities were

Table 4. Empirical results – Financial crisis model.

Panel A: Banking crisis, diversification and performance

	(1) ROE	*(2)* ROE	*(3)* ROE	*(4)* ROA	*(5)* ROA	*(6)* ROA
AD	-0.027			0.002		
	(0.093)			(0.010)		
ID		-0.009			0.008	
		(0.065)			(0.007)	
FD			0.566***			0.050***
			(0.108)			(0.009)
ADxCRI	0.519**			0.038*		
	(0.223)			(0.022)		
IDxCRI		0.442***			0.043***	
		(0.133)			(0.012)	
FDxCRI			-0.458*			-0.045*
			(0.257)			(0.025)
CRISIS	-0.297**	-0.089***	0.199	-0.022*	-0.008***	0.019
	(0.122)	(0.023)	(0.133)	(0.012)	(0.002)	(0.013)
_cons	-0.419***	-0.327***	-0.866***	-0.026*	-0.029***	-0.073***
	(0.108)	(0.095)	(0.176)	(0.013)	(0.010)	(0.013)
No. of Obs	365	393	393	365	393	393
AR (1)	0.223	0.066	0.046	0.120	0.026	0.006
AR (2)	0.147	0.150	0.878	0.103	0.185	0.428
Hansen test	0.013	0.260	0.203	0.147	0.326	0.197

Panel B: Banking crisis, diversification and risk

	(1) SDROE	*(2)* SDROE	*(3)* SDROE	*(4)* SDROA	*(5)* SDROA	*(6)* SDROA	*(7)* ZSCORE	*(8)* ZSCORE	*(9)* ZSCORE
AD	-0.063			-0.005			-0.601		
	(0.054)			(0.004)			(5.912)		
ID		0.129***			0.006*			2.353	
		(0.026)			(0.004)			(2.542)	
FD			0.191***			0.016***			3.730
			(0.067)			(0.006)			(5.068)
ADxCRI	0.118			0.016**			12.031		
	(0.105)			(0.007)			(12.032)		
IDxCRI		-0.048			0.010			5.358	
		(0.041)			(0.007)			(6.193)	
FDxCRI			-0.309*			-0.014			7.254
			(0.154)			(0.012)			(7.999)
CRISIS	-0.066	0.013	0.159*	-0.008**	-0.000	0.008	-6.930	-1.766**	-4.955
	(0.055)	(0.009)	(0.079)	(0.004)	(0.001)	(0.006)	(6.521)	(0.812)	(4.206)
_cons	0.087*	0.105***	-0.159*	0.018***	0.014***	-0.010	1.660	12.919	3.649
	(0.047)	(0.024)	(0.086)	(0.005)	(0.005)	(0.010)	(10.282)	(9.621)	(13.050)
N	365	393	393	365	393	393	365	393	393
AR (1)	0.015	0.000	0.033	0.132	0.071	0.109	0.158	0.556	0.568
AR (2)	0.100	0.107	0.172	0.591	0.875	0.644	0.946	0.789	0.837
Hansen test	0.228	0.178	0.847	0.158	0.211	0.362	0.169	0.348	0.372

Note: The sample includes 34 banks in Vietnam, over the period 2005-2019. The dependent variables are returns on assets and returns on equity (ROA, ROE), the standard deviation of returns (SDROA, SDROE), and bankruptcy risk (ZSCORE). Key explanatory variables are diversification indexes: Asset (AD), Income (ID), Funding (FD); and their interaction terms with financial crisis: ADxCRI, IDxCRI and FDxCRI, respectively. Other control variables, not shown in this Table, are the Equity to Total Asset ratio (ETA), Logarithm of total assets (LNASSET), Loan loss provision (LLP), and macro factors (GDP and INF). Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 5. Empirical results – Strategy combination model.

Panel A: Diversification strategy combination and bank performance

	(1) ROA	*(2)* ROA	*(3)* ROA	*(4)* ROA
AD	0.064**	-0.150**		-0.049***
	(0.026)	(0.060)		(0.018)
FD	0.243**	-0.097	-0.014	0.002
	(0.099)	(0.065)	(0.015)	(0.022)
ID			-0.064*	-0.077
			(0.037)	(0.051)
ADxID	-0.393**			
	(0.178)			
FDxAD		0.251**		
		(0.120)		
IDxFD			0.172**	
			(0.073)	
ADxIDxFD				0.381**
				(0.186)
_cons	-0.032	0.041	-0.023*	-0.004
	(0.019)	(0.037)	(0.012)	(0.021)
No. of Obs	364	364	392	363
AR (1)	0.189	0.120	0.149	0.092
AR (2)	0.669	0.965	0.922	0.720
Hansen test	0.456	0.231	0.566	0.637

Panel B: Diversification strategy combination and bank risk

	(1) SDROA	*(2)* SDROA	*(3)* SDROA	*(4)* SDROA	*(5)* ZSCORE	*(6)* ZSCORE	*(7)* ZSCORE	*(8)* ZSCORE
AD	0.014*	-0.087***		-0.026***	34.049	-50.594		-60.87***
	(0.008)	(0.022)		(0.007)	(29.345)	(39.362)		(12.537)
FD		-0.084***	0.005	-0.010		-39.570	-45.922**	-60.64***
		(0.024)	(0.008)	(0.010)		(42.430)	(19.731)	(17.355)
ID	0.050**		0.004	-0.065***	109.859		-101.12**	-153.6***
	(0.023)		(0.014)	(0.018)	(88.345)		(46.556)	(32.019)
ADxID	-0.087*				-186.060			
	(0.044)				(158.98)			
FDxAD		0.166***				95.581		
		(0.045)				(79.794)		
IDxFD			0.000				214.09**	
			(0.029)				(92.448)	
ADxIDxFD				0.233***				636.68***
				(0.066)				(120.24)
_cons	0.007	0.061***	0.010	0.031***	-12.255	17.525	52.124***	66.517***
	(0.006)	(0.015)	(0.010)	(0.009)	(19.194)	(24.471)	(17.865)	(17.734)
No. of Obs	364	364	392	363	364	364	392	363
AR (1)	0.116	0.064	0.070	0.066	0.008	0.049	0.028	0.061
AR (2)	0.017	0.290	0.304	0.162	0.104	0.138	0.109	0.113
Hansen test	0.499	0.097	0.284	0.448	0.193	0.453	0.240	0.188

Note: The sample includes 34 banks in Vietnam, over the period 2005-2019. The dependent variables are returns on assets (ROA), the standard deviation of return on assets (SDROA), and bankruptcy risk (ZSCORE). Key explanatory variables are diversification indexes: Asset (AD), Income (ID), Funding (FD); and their interaction between one another: ADxID, FDxAD, IDxFD and ADxIDxFD. Other control variables, not shown in this Table are the Equity to Total Asset ratio (ETA), Logarithm of total assets (LNASSET), Loan loss provision (LLP), and macro factors (GDP and INF). Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

seriously affected and resulted in increased non-performing loans and liquidity risks. Therefore, in a crisis period, diversifying income to non-interest sources, such as brokerage services, is to rescue banks to overcome financial hardship in the crisis and economic recession. In terms of risk, income diversification increases bank risk and helps reduce volatility (SDROE) during the crisis. Therefore, we can conclude that diversifying income is the most effective strategy during the crisis as the profit-saving solution without any potential risk. This result is consistent with the economic theory and traditional business administration theory. These theories state that more diversified-income banks benefit their profitability due to advantages of economies of scale and scope, while enjoying lower risk, due to minimized bank's returns volatility, and hence increase stability in the long term (Luu et al., 2019; Meslier et al., 2014; Sanya & Wolfe, 2011).

3.4. Diversification strategies combination, bank performance, and risk

Another major contribution of this study is to consider the interactions between diversification strategies and investigate if a combination of two or three diversification strategies impacts bank risk and return, positively or negatively. Table 5 shows the results of the strategy combination model. When asset diversification is combined with another strategy (interacting with another strategy), both return and risk impact is significant. However, the effect difference if asset diversification is combined with either income or funding diversification. When asset and income diversification (ADxID) are interactive, this strategy reduces both return and risk value. Conversely, when asset and funding diversity (ADxFD) are combined, this strategy increases both return and risks. These findings suggest that the two mentioned diversification combinations should be carefully considered and depend on whether the bank's goal is to increase profits (ADxFD is preferred) or manage risk (ADxID is preferred). Second, as risks and returns go up or down together, these diversification combinations seem non-optimal and do not adhere to the modern portfolio theory, suggesting that diversification could maximize return for a given amount of risk (Markowitz, 1959). The same result occurs when using all three strategies at the same time. This combination (ADxIDxFD) significantly increases both return and volatility risk. However, this tactic also significantly impacts return volatility. Furthermore, using multiple diversification strategies at the same time takes a lot of resources and increases the return's fluctuation (impact on the SDROA is huge). The only combination that relatively satisfies the modern portfolio theory is funding and income diversifications (IDxFD). In this case, profit increases significantly, and default risk (ZSCORE) also reduces significantly, which seems to be the best matching strategy.

3.5. Robustness check

For robustness testing, we replace the diversification variables with a more direct alternative measure of diversification: the accounting ratio (Edirisuriya et al., 2015; Khan, Scheule, & Wu, 2017; Meslier et al., 2014; Moudud-Ul-Huq et al., 2018)[3]. Also, we add two new dependent variables, risk-adjusted returns (RAROA, RAROE). The robustness test shows consistent results with the baseline model (see appendix 4).

4. Conclusion

This study investigates and finds strong evidence of income and funding diversification strategies on bank risk and performance in Vietnam. The finding is consistent with studies conducted in developed markets, which found that a larger share in non-interest income could positively affect banks' stock price (Edirisuriya et al., 2015; Mercieca et al., 2007). For asset diversification effectiveness, while some authors found evidence to advocate for the positive

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[3] Detailed calculations of diversification level for robustness test are shown in Appendix 3.

effects of asset diversification on bank performances (Moudud-Ul-Huq et al., 2018), the others found negative impacts (Chen et al., 2018; Curi et al., 2015). In this paper, evidence from the Vietnam banking system post additional arguments to the mixed results on the topic when found insignificant impacts of asset diversification on bank risk-performance profile, in general. This finding could partly be explained why there is a downward trend in the asset diversification index of Vietnamese banking systems from 2011 to 2019 (see Figure 1).

However, in the banking crisis period, this study found that asset diversification implementation could benefit bank performance while do not significantly increase risk (Table 4). The same conclusion could be drawn for income diversification in the banking crisis but not for funding diversification. The findings are consistent with Curi et al. (2015), one of the very few studies that incorporated crisis into the banking system's diversification topic. However, banks should carefully consider the extent of diversification as higher diversification leads to higher return volatility during the crisis.

It seems that each diversification strategy impacts bank risk and returns differently, even during the banking crisis period. This indicates that commercial bank managers need to formulate their decisions regarding the concentration or diversification strategies thoroughly. The difficulties in transferring assets, funding, or income structures make this decision extremely essential for bank performance and risk in the long term.

This paper also explores how diversification strategies could be combined to affect bank risk-return profile as a novel approach to bank diversification practices. The results advocate using a combination of funding and income diversification to improve bank returns and reduce bank risk. Future research could explore more evidence on this research direction in other contexts for a novel approach to diversification practices in the banking sector.

Acknowledgements

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Appendix 1. Measurement of bank diversification indexes.

Asset diversity (AD), for each bank i at time t, is formulated as follows:

$$AD_{i,t} = 1 - HHI = 1 - \left(\left(\frac{CLOANi,t}{EAi,t} \right)^2 + \left(\frac{IBLOANi,t}{EAi,t} \right)^2 + \left(\frac{SECi,t}{EAi,t} \right)^2 + \left(\frac{OTHERi,t}{EAi,t} \right)^2 \right)$$

where earning assets (EA) is the sum of the four numerators: interbank loans (IBLOAN), customer loans (CLOAN), securities (SEC), and other earning assets (OTHER).

Funding diversification (FD) of each bank i at time t is calculated:

$$FD_{i,t} = 1 - \left(\left(\frac{EQUIi,t}{FUNDi,t} \right)^2 + \left(\frac{IBDi,t}{FUNDi,t} \right)^2 + \left(\frac{CDEPi,t}{FUNDi,t} \right)^2 + \left(\frac{ODSTBi,t}{FUNDi,t} \right)^2 \right.$$
$$\left. + \left(\frac{OTHERi,t}{FUNDi,t} \right)^2 \right)$$

where denominator FUND is a total of five factors: equity (EQUI), deposits from other banks and institutions (IBD), deposits from customers (CDEP), other deposits & short-term borrow (ODSTB), and other non-interest bearings (OTHER).

Similarly, the income diversification index (ID) for bank i in year t is calculated:

$$ID_{i,t} = 1 - \left(\left(\frac{IIi,t}{TOIi,t} \right)^2 + \left(\frac{NFACi,t}{TOIi,t} \right)^2 + \left(\frac{NGOTi,t}{TOIi,t} \right)^2 + \left(\frac{ROIi,t}{TOIi,t} \right)^2 \right)$$

where total operating income (TOI) is defined as the total of four factors: interest income (II), net fee and commission income (NFAC), net gain on trading & derivatives (NGOT), and remaining Operating Income (ROI).

Appendix 2. Measurements of bank risk – dependent variables.

Following Amidu and Wolfe (2013); Vo (2018), the study employs the following risk proxies for the baseline model and robustness test: standard deviations of return on asset and standard deviation of return on equity; and, bankruptcy risk ZSCORE. ZSCORE is formulated as below:

$$ZSCORE = \frac{ROA + ETA}{SDROA}$$

where ROA is returns on assets; ETA is the ratio of total equity to total assets; and, SDROA is standard deviations of returns on assets.

Appendix 3. Measurement of diversification indexes and bank risk for robustness check.

For robustness test model, the study employs measures of return on average assets (RAROA) and risk-adjusted return on average equity (RAROE) by dividing ROA and ROE by their standard deviation calculated over three-year rolling windows. The calculations are as follows:

$$RAROA = \frac{ROA}{SDROA}$$
$$RAROE = \frac{ROE}{SDROE}$$

where RAROA and RAROE are risk-adjusted returns on assets and equity, respectively; SDROA and SDROE are standard deviations of returns on assets and equity, respectively.

Assets diversification (AD) is calculated by dividing the share of non-interest-bearing assets (including securities and investments) by total bank assets. This numerator is estimated by subtracting the total loans and advances from total bank assets. The higher the AD value, the more diversified the portfolio of banking assets. In equation, AD is computed as follows:

$$AD = \frac{Total\ assets - Loans}{Total\ assets}$$

Funding diversity (FD) is measured by dividing the share of non-deposits in total assets. The higher the proportion of non-deposit sources, the higher the bank funding diversity. In equation, FD is computed as follows:

$$FD = \frac{Total\ Assets - Total\ deposits}{Total\ Assets}$$

Income diversification (ID) equals the ratio of non-interest income, such as fees, commissions, trading and other non-interest income, to total income, where total income is the summation of total interest income and non-interest income. The higher value of ID, the more diversified the bank income and vice versa. In equation, ID is computed as follows:

$$ID = \frac{Non - Interest\ income}{Total\ income}$$

Appendix 4. Robustness test results.

Panel A: Diversification and bank performance

	(1) ROE	(2) ROE	(3) ROE	(4) ROA	(5) ROA	(6) ROA
AD	0.216*** (0.046)			0.028*** (0.006)		
ID		0.302*** (0.074)			0.052*** (0.007)	
FD			0.428*** (0.049)			0.035*** (0.006)
_cons	-0.282** (0.117)	-0.075 (0.079)	-0.522*** (0.119)	-0.027** (0.012)	0.009 (0.009)	-0.032*** (0.011)
No. of Obs	426	416	426	426	416	426
AR (1)	0.043	0.145	0.035	0.109	0.051	0.043
AR (2)	0.146	0.109	0.117	0.108	0.138	0.144
Hansen test	0.183	0.132	0.197	0.156	0.104	0.179

Panel B: Diversification and bank risk

	(1) ZSCORE	(2) ZSCORE	(3) ZSCORE	(4) RAROE	(5) RAROE	(6) RAROE	(7) RAROA	(8) RAROA	(9) RAROA
AD	19.033** (7.152)			2.869*** (0.821)			2.869*** (0.821)		
ID		13.956*** (1.962)			3.520*** (1.013)			3.520*** (1.013)	
FD			15.500*** (3.525)			5.545*** (0.836)			5.545*** (0.836)
_cons	2.130 (12.395)	24.744** (11.238)	3.596 (7.376)	-2.705 (1.768)	-0.185 (1.409)	-5.277*** (1.704)	-2.705 (1.768)	-0.185 (1.409)	-5.277*** (1.704)
No. of Obs	426	416	426	426	416	426	426	416	426
AR (1)	0.141	0.513	0.327	0.012	0.006	0.002	0.012	0.006	0.002
AR (2)	0.813	0.848	0.854	0.111	0.149	0.147	0.111	0.149	0.147
Hansen test	0.259	0.161	0.417	0.125	0.120	0.170	0.125	0.120	0.170

Note: The sample includes 34 banks in Vietnam, over the period 2005-2019. The dependent variables are returns on assets and returns on equity (ROA, ROE), risk adjusted of returns (RAROA, RAROE), and bankruptcy risk (ZSCORE). Key explanatory variables are diversification indexes: Asset (AD), Income (ID), Funding (FD) diversities. Other control variables, not shown in the Table, are the Equity to Total Asset ratio (ETA), Logarithm of total assets (LNASSET), Loan loss provision (LLP), and macroeconomic factors (GDP and INF). Standard errors in parentheses * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.