

Revenue Diversification and Banks Funding Costs under Financial Regulation

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ABSTRACT

The banking literature suggests that banks can reduce their funding costs by optimising their deposit mix to prioritise low-cost accounts, managing capital efficiently, and employing diversification strategies to attract more cost-effective funding sources. While the roles of deposit mix optimisation and capital management in lowering funding costs are well documented, the impact of diversification remains relatively underexplored, particularly in the Indonesian context. This study examines the relationship between diversification, financial regulations, and banks' funding costs in Indonesia. A sample of 87 commercial banks operating in Indonesia over the period 2010 to 2024 was selected based on the availability of data. This study employs the fixed effects model as the main estimation approach, along with two-stage least squares (2SLS) and generalised method of moments (GMM) estimation techniques for robustness testing. The results indicate that diversification significantly lowers banks' cost of funds in Indonesia. The analysis also reveals that revenue diversification has a more pronounced impact on large and foreign or joint venture banks. Furthermore, the study identifies an indirect effect of financial regulations on banks' funding costs through revenue diversification. The study highlights the need for bank managers, particularly those in large and foreign or joint venture banks, to proactively adopt diversification strategies to optimise their funding structures and reduce costs effectively. The study provides insights into the broader implications of the interactions between regulatory frameworks, bank diversification, and funding costs in Indonesia. revenue diversification; asset diversification; financial regulations; banks' funding costs; Indonesia.

Keywords: Revenue Diversification, Asset Diversification, Financial Regulations, Banks' Funding Costs.

INTRODUCTION

Bank funding costs refer to the expenses incurred by banks to finance their business activities (Nguyen, Tran & Nguyen 2024). These costs are critical to bank operations and the overall economy, as they directly influence the lending and borrowing behaviour of market participants. More specifically, higher funding costs can harm the real economy by driving up lending rates, which may suppress loan demand and weaken economic activities. In addition, these increased costs can heighten banks' liquidity risk, which can adversely affect the stability of the financial system (Andrieş & Sprincean 2023). Therefore, reducing funding costs is of utmost importance for ensuring the resilience and functionality of banks in the economy. The literature suggests that banks can lower their funding costs by optimising their deposit mix to prioritise low-cost accounts, managing capital effectively to improve credit ratings, and employing diversification strategies to attract more cost-effective funding sources (Hunjra et al., 2021)(Ben et al. 2023).

While studies (Čehajić & Košak 2021; Tran & Nguyen 2023; Nguyen et al. 2024) have documented the role of deposit mix optimisation and capital management in reducing funding costs, the effect of diversification remains relatively underexplored. In the banking context, diversification refers to a strategy of spreading income and assets over different financial instruments and businesses to reduce risks and enhance profitability (Addai et al., 2022; Adem, 2022). According to Levine, (Adesina, 2021; Agnese & Giacomini, 2023), diversification can influence bank funding costs in two distinct ways. On the one hand, drawing from modern portfolio theory, engaging in diverse activities is expected to reduce risk, thereby decreasing funding costs for diversified banks. In contrast, (Aldasoro et al., 2022; Andrieş & Sprincean, 2023) observes that diversification may increase the complexity of a bank's operations, thereby potentially elevating the perceived risk among investors and creditors. This could lead to higher funding costs, as lenders and investors may demand higher returns to offset the increased risk. Besides, diversification can lead to inefficiencies when banks expand beyond their core

competencies, potentially diluting overall returns and increasing the cost of raising funds (Avdjiev et al., 2022)(Huynh & Dang 2022).

Given the theoretical ambiguity in predicting the relationship between diversification and funding costs, it is essential to explore how diversification specifically affects banks' funding costs. In the literature, a large number of studies have explored the link between income diversification on bank stability (Adem 2022; Shabir et al. 2024; Shahriar, Mehzabin & Azad 2023), performance (Addai et al. 2022; Adesina 2021), and environmental social and governance (ESG) performance (Agnese & Giacomini 2023; Saif-Alyousfi, Saha & Alshammari 2023). Studies have also explored the effect of geographical diversification (Levine et al. 2021), credit ratings, solvency risk, ESG (Agnese & Giacomini 2023; Andrieş & Sprincean 2023), and management quality (Nguyen et al. 2024) on bank funding costs. However, empirical evidence on the relationship between income diversification, asset diversification, and funding costs remains scant, particularly in emerging economies such as Indonesia.

Indonesia's banking sector presents a compelling case for this investigation. The country hosts a diverse set of commercial banks spanning state-owned institutions, private national banks, regional development banks, and foreign or joint venture banks, each operating under different regulatory environments and diversification incentives. Funding costs as a share of total interest-bearing liabilities declined markedly for state-owned banks from an average of 6.8% in 2010 to 3.7% in 2024, mirroring a rising trend in revenue diversification (see Figure 1). In contrast, regional development banks maintained higher funding costs throughout this period, partly reflecting their limited diversification capacity. Furthermore, Addai et al. (2022) observe that limited demand for diversified financial products, coupled with varying information environments across bank types, hinders the full realisation of diversification benefits in developing economies. Consequently, banks operating in these markets may not uniformly capture the gains from diversification.

Therefore, this study aims to provide empirical evidence on the effect of revenue and asset diversification on banks' funding costs in Indonesia, utilising data from 87 commercial banks from 2010 to 2024. In addition, it investigates the potential indirect effects of financial regulation on this relationship. Shabir et al. (2024) observe that while financial regulations have been introduced to mitigate banks' default risk and enhance overall financial system stability, these regulations significantly influence banks' decisions to diversify or concentrate their portfolios. Accordingly, by examining the indirect effects of financial regulations, this article aims to offer deeper insights into how regulatory frameworks might influence diversification and funding outcomes within a single emerging market context.

The article adds to the literature on the consequences of diversification on banks' funding costs. While prior related studies (Levine et al. 2021) have primarily concentrated on geographical diversification in developed markets, this study takes a distinct approach by focusing on revenue and asset diversification. Moreover, by studying the Indonesian banking industry, the study addresses a notable gap in the existing literature (Ben Lahouel et al., 2023, 2024; Čehajić & Košak, 2021), which typically concentrates on developed economies or pan-continental samples. This focus offers valuable perspectives into the unique intricacies of diversification and funding costs in a middle-income emerging market.

Lastly, by examining the indirect effects of financial regulation, the study provides insights into the broader implications of the interactions between regulatory frameworks, bank diversification, and funding costs. This analysis is conducted across various subsamples, including differences in bank size and distinctions between domestic and foreign or joint venture banks. This approach yields a more comprehensive understanding of the indirect effects of financial regulation across varied banking contexts.

LITERATURE AND HYPOTHESIS DEVELOPMENT

Diversification and Banks' Funding Costs

While empirical evidence regarding the relationship between diversification and banks' funding costs is limited, the theoretical literature presents mixed predictions. The modern portfolio theory suggests that diversification can reduce banks' overall risk by lowering the volatility of profits (Duho et al., 2020)(Ben et al. 2023). This perceived reduction in risk can, in turn, attract more investors and depositors, subsequently leading to lower funding costs for banks. However, the literature on income diversification (Githaiga, 2021; Huynh & Dang, 2022)(Wang 2023) suggests that diversified firms often face inefficient resource allocation because of agency problems, leading to a discount in their valuation. This decreased valuation, reflecting higher perceived

risks and management complexities, can subsequently increase the cost of capital for diversified banks as investors demand higher returns to compensate for the increased risk.

Studies have predominantly focused on the effect of diversification on bank stability. For example, Adem (2022) examines the effect of income diversification on bank stability, providing evidence that diversification of income reduces risk and improves bank stability in developing and emerging economies. More recently, Shabir et al. (2024) study the effect of diversification on bank stability in the MENA region. Their findings show that both income and asset diversification improve bank stability. Another strand of literature looks at the impact of diversification on bank performance. (X. Li et al., 2021; C. Wang & Lin, 2021; Y. Wang, 2023), for instance, examine the interaction between income diversification and bank performance in Africa. Similarly, Adesina (2021) analyses the relationship between diversification and bank performance, showing evidence that greater income and asset diversification reduces bank stability, cost efficiency, and profitability in some contexts.

Few studies have explored the link between diversification and bank ESG performance. Saif-Alyousfi et al. (2023), for example, analyse whether bank ESG activities affect their income and asset diversification. Their results indicate that environmental and social factors negatively impact bank diversification. A recent study by Kamau and Simo-Kengne (2024) investigates the relationship between legal origin, diversification, and bank lending behaviour in Africa, finding evidence that revenue diversification indirectly mitigates the negative impacts of loan growth in banks with a common-law legal origin. Turning to banks' funding costs, studies have largely examined the effect of bank solvency risk and funding costs. A related study by Levine et al. (2021) analyses the impact of geographical diversification on the costs of interest-bearing liabilities for banks across the United States. A growing body of literature has explored the effects of ESG performance on banks' funding costs.

Works have also examined the relationship between credit quality indicators and bank funding costs. For instance, Andrieş and Sprincean (2023) study the effect of ESG performance on banks' funding costs, finding strong evidence that better sustainability performance reduces the premium demanded by investors. Most recently, Nguyen et al. (2024) investigated whether banks with more capable managers achieve better funding costs. According to their findings, banks with strong managerial abilities are able to secure funding at reduced costs.

From the reviewed literature, it is clear that no study has specifically explored the impact of diversification on bank funding costs within the Indonesian context. Accordingly, this study argues that diversification will likely reduce banks' cost of funds in Indonesia for two primary reasons. Firstly, diversification can help mitigate risk, especially in Indonesia, where banks face persistent challenges related to credit quality and sectoral concentration. Secondly, diversification can provide banks in the country with enhanced access to a wider range of funding sources and earnings, leading to improved liquidity and stability. Consequently, this study proposes the following hypothesis:

H1: Diversification is negatively associated with banks' funding costs in Indonesia.

Financial Regulation, Diversification, and Bank Funding Costs

Financial regulations designed to curtail non-traditional banking activities have become critical tools in the aftermath of financial crises (Ben et al. 2023). These regulations were largely implemented in response to the realisation that many large financial institutions had failed because of extensive involvement in non-traditional and often risky financial activities. Literature (Duho et al., 2023; Sarpong & Adu-Asare Idun, 2024) argues that financial regulation indirectly influences banks' cost of funds through diversification. For instance, regulatory capital requirements may encourage banks to diversify their income and assets in order to hold lower capital levels. Furthermore, regulations such as deposit rate caps could drive banks to explore alternative income and funding sources (Wang & Lin 2021).

Regulatory constraints may lead to a suboptimal allocation of resources by steering banks towards investments that are safer but yield lower returns (Ben et al. 2023). This shift can paradoxically result in reduced income and higher funding costs, as banks may be compelled to offer higher interest rates to attract capital. Prior studies (Khattak et al., 2023)(Poshakwale et al., 2020)demonstrate that capital regulations enhance banks' capital, enabling them to pursue greater diversification. This diversification can lead to more stable income streams and reduce the volatility of a bank's overall financial performance, which can lower the risk premium demanded on capital lent to or invested in the bank. (Kouzez, 2023; Levine et al., 2021) finds an indirect effect of regulatory capital on bank diversification. Accordingly, this study anticipates that financial regulations will

indirectly influence funding costs through diversification. Consequently, the article proposes the following hypothesis:

H2: Financial regulations affect banks' funding costs through diversification.

DATA AND METHODS

Sample and Data Sources

This study investigates the effects of diversification on banks' funding costs using a sample of 87 commercial banks in Indonesia from 2010 to 2024. The selection of these banks was based on the availability of consistent data over the study period. Bank-level data are sourced from the OJK (Otoritas Jasa Keuangan) Bank Financial Reports Database, while data on financial regulations and macroeconomic variables are obtained from the World Bank's World Development Indicators (WDI) and Bank Indonesia's Financial Statistics databases.

Variables and Measurement

Measures of Banks' Funding Costs

The dependent variable is banks' funding costs measured as the ratio of interest expense to interest-bearing liabilities following Levine et al. (2021). This measure captures the significance of the effect of financial distress on banks' performance.

Measures of Revenue Diversification

This study employs two measures of revenue diversification: Revenue diversification (RDIV) and adjusted revenue diversification (ARDIV), consistent with previous related works (Nguyen et al., 2024; Poshakwale et al., 2020; Saif-Alyousfi et al., 2023). RDIV considers the interest and non-interest sources of income and is calculated using the Herfindahl-Hirshman index (HHI) as follows:

$$RDIV_{ikt} = 1 - \left[\left(\frac{NON_{ikt}}{TOR_{ikt}} \right)^2 + \left(\frac{NIR_{ikt}}{TOR_{ikt}} \right)^2 \right] \quad (1)$$

NON is the non-interest income, NIR is the net interest income, and TOR is the total operating revenue for bank i at year t . Adjusted revenue diversification breaks non-interest income into net fee and commission income, net trading income, and other operating income. The ARDIV is calculated as follows:

$$ARDIV_{ikt} = 1 - \left[\left(\frac{NIR_{ikt}}{TOR_{ikt}} \right)^2 + \left(\frac{NFC_{ikt}}{TOR_{ikt}} \right)^2 + \left(\frac{NGT_{ikt}}{TOR_{ikt}} \right)^2 + \left(\frac{OOI_{ikt}}{T.F.}_{ikt} \right)^2 \right] \quad (2)$$

NFC is the net fee and commission income, NGT is net gains on trading, and OOI is other operating income.

Measures of Asset Diversification

This study adopts the asset diversification (ADIV) and the adjusted asset diversification (AADIV) measures following Levine et al. (2021) and Velasco (2022). Asset diversification is calculated using the HHI of asset diversification as follows:

$$ADIV_{ikt} = 1 - \left[\left(\frac{NI_{ikt}}{TA_{ikt}} \right)^2 + \left(\frac{OA_{ikt}}{TA_{ikt}} \right)^2 \right] \quad (3)$$

NI is the net loans of bank i at year t , OA is other assets, and TA is total assets. Adjusted asset diversification is calculated as follows:

$$AADIV_{ikt} = \frac{\text{Non - interest bearing assets}}{\text{Total assets}} \quad (4)$$

Measures of Financial Regulation

Following (Hunjra et al., 2021)(Shahriar et al., 2023; Tran et al., 2024; Tran & Nguyen, 2023), this study employs two commonly used proxies for financial regulation: a dummy value equal to 1 for periods in which Indonesia's LPS (Lembaga Penjamin Simpanan) imposed deposit rate caps and 0 otherwise, and a dummy variable equal to 1 for banks that have fully adopted Basel II or III capital accords as mandated by OJK and 0 otherwise. The use of two proxies, deposit rate controls and Basel Accord compliance, allows the study to capture key dimensions of financial regulation, thereby enhancing the reliability of the results.

Control Variables

This study incorporates both bank-specific and macroeconomic control variables, which have been identified in previous studies (Alouane et al., 2022; X. Li et al., 2021; Maghyreh & Yamani, 2022) to influence bank funding costs. Bank-specific control variables include equity, bank size, and return on assets (ROA). According to Saif-Alyousfi et al. (2023), well-capitalised banks are viewed as less risky, making them raise funds at a cheaper cost. Therefore, a negative relationship between equity and banks' funding costs is expected. Equity is measured as a ratio of equity to total assets. Literature provides mixed predictions on the direction of the relationship between bank size and funding costs. On the one hand, (Saif-Alyousfi et al., 2023) show that bigger banks enjoy lower funding costs because they are perceived as 'too big to fail'. Conversely, large banks seek more deposits to lend to borrowers, leading to higher interest expenses and potentially increasing their overall funding costs (Kouzez 2023). Thus, the expected sign for the coefficient of bank size is unclear. Bank size is measured as the log of total assets. ROA is a proxy for bank profitability calculated as net income divided by total assets. The coefficient for ROA is expected to be negative, as highly profitable banks may be seen as efficient by investors and thus rewarded with lower funding costs (Andrieş & Sprincean, 2023).

For macroeconomic variables, the study includes controls for the policy rate (BI Rate), inflation, gross domestic product (GDP) growth, and financial crisis. The BI Rate directly affects the interest rates that banks pay to obtain funds (Lee et al., 2020; W. Li et al., 2022; Meslier et al., 2020). Accordingly, the policy rate is expected to positively affect banks' funding costs. GDP growth improves a country's economic conditions, simultaneously lowering the riskiness of banks and enhancing the conditions for raising loans (Nguyen et al. 2024). This can result in reduced funding costs. Therefore, this study expects GDP growth, measured as the percentage change in real GDP, to negatively influence banks' funding costs. Shabir et al. (2024) observe that a rise in inflation rates increases borrowing costs because investors demand higher rates of return on their investments. Thus, inflation is expected to be positively related to the dependent variable. Lastly, crisis is a proxy for the economic crisis, which assumes a dummy value of 1 for the period 2020 to 2021 (COVID-19 pandemic) and 0 otherwise. (Sarpong & Adu-Asare Idun, 2024) find that economic crises lead to increased banks' funding costs because of the deterioration of money markets and a subsequent increase in financial instruments' risk premium. Consequently, this study expects a positive coefficient for the crisis variable. Table 1 provides a summary description of the study variables.

Table 1. Description of the variables.

Variable	Definition	Source
Dependent variable		
Funding costs	Interest expense divided by interest-bearing liabilities	OJK, own calculations
Independent variables		
RDIV	HHI based on interest and non-interest income	OJK, own calculation
ARDIV	HHI based on net fee and commission income, net gains on trading, and other operating income	OJK, own calculation
ADIV	HHI based on loans and other assets	OJK, own calculation
AADIV	Non-interest-bearing assets over total assets	OJK, own calculation
Financial regulation variables		
Interest rate controls	A dummy value of 1 for periods with LPS deposit rate caps and 0 otherwise	Bank Indonesia
Basel	A dummy variable equal to 1 for banks that have fully adopted Basel II or III capital accords and 0 otherwise	OJK
Bank-specific control variables		
Equity	Equity to total assets	OJK, own calculation
Size	Logarithm of total assets	OJK, own calculation
ROA	Net income to total assets	OJK, own calculation
Macroeconomic control variables		

Policy rate	BI Rate (monetary policy rate)	Bank Indonesia
Inflation	Inflation rate	BPS, WDI
GDP growth	Percentage change in a country's real gross domestic product	WDI, own calculations
Crisis	Economic crisis dummy (0 to 1) covering 2020 to 2021	Own calculation

ROA, return on assets; WDI, World Development Indicators; OJK, Otoritas Jasa Keuangan; AADIV, adjusted asset diversification; ADIV, asset diversification; ARDIV, adjusted revenue diversification; HHI, Herfindahl-Hirshman index; RDIV, revenue diversification.

Regression Model

This study employs the following baseline model to test hypothesis 1, which examines the effects of diversification on banks' funding costs, following prior related studies of Agnese and Giacomini (2023) and Wang and Lin (2021):

$$FC_{it} = \alpha + \beta_1 DIV_{it} + \sum_{j=1}^7 \theta_j Controls_{jt} + \alpha_i + \lambda_t + \varepsilon'_{it} \quad (5)$$

FC_{it} denotes funding costs of bank i in year t . DIV indicates bank diversification, which can either be revenue or asset diversification. Controls represent the vector of bank-specific (equity, bank size, and ROA) and macroeconomic control variables (policy rate, inflation, GDP growth, and financial crisis). In addition, the study includes bank (α_i) and year (λ_t) fixed effects to control for bank-specific and time-varying unobserved heterogeneity. The baseline regression model is estimated using the fixed effects model following the results of the Hausman test and Wang and Lin (2021).

As mentioned earlier, given the potential indirect influence of financial regulation on diversification, this study employs the two-stage least square (2SLS) method. The 2SLS approach also controls for endogeneity, which is a common concern in the diversification literature (Šeho et al., 2024). Such endogeneity may arise because the decision to diversify is at the bank's discretion; hence the bank-specific factors that influence the revenue diversification strategy may also affect funding costs. Moreover, reverse causality may arise because the decision to diversify a bank's revenue sources may be influenced by past costs of funds (Velasco 2022). In the first stage, the predicted values of diversification are estimated based on the instrumental variables using the following model:

$$DIV_{it} = \beta_1 Z_{it} + \sum_{j=1}^7 \theta_j Controls_{jt} + \alpha_i + \lambda_t + \varepsilon'_{it} \quad (6)$$

DIV_{it} is the predicted values of diversification and β_1 is the coefficient of the instrumental variable Z_{it} . The study uses the financial regulation proxies (a dummy variable for deposit rate control and a dummy variable for the adoption of Basel II or Basel III capital) as instruments for revenue and asset diversification. This approach is based on the idea that banks will likely diversify their income and assets to increase earnings when faced with deposit rate ceilings. Similarly, the adoption of Basel capital accords, particularly the Basel II and Basel III frameworks, has been observed to drive more diversification in the banking industry (Velasco, 2022).

In the second stage, the predicted values of diversification are used as exogenous variables to estimate the effect of diversification on banks' funding costs as follows:

$$FC_{it} = \alpha + \beta_1 \overline{DIV}_{it} + \sum_{j=1}^7 \theta_j Controls_{jt} + \alpha_i + \lambda_t + \varepsilon'_{it} \quad (7)$$

The article employs the Sargan test and the Lagrange Multiplier (LM) test to assess the relevance and validity of the 2SLS instrumental variables. Furthermore, the study utilises the Generalised Method of Moments (GMM) estimator to check the robustness of the baseline results. Unlike the first two estimators, the GMM approach accounts for both endogeneity and the persistence of the dependent variable, whereby the previous year's banks' funding costs are likely to influence the current year's banks' funding costs (Saif-Alyousfi et al. 2023). This study uses the two-step system GMM estimator, which is considered more efficient than the one-step (Khattak et al. 2023). The first step of the two-step GMM is used to generate the instruments for the second-step equation, and it involves estimating the coefficients of the first differenced equation of the endogenous variable. The first step equation can be modelled as follows:

$$DIV_{it} = \sum_{i=1}^k \rho_i DIV_{it-1} + \sum_{j=1}^7 \vartheta_j Controls_{jt} + \alpha_i + \lambda_t + \mu_{it} \quad (8)$$

DIV_{it} is revenue or asset diversification for bank i at year t . DIV_{it-1} is the lagged values of revenue or asset diversification. α_i and λ_t are bank and year fixed effects, respectively, while μ_{it} is the error term. The second-step regression of the two-step system GMM involves estimating the effect of diversification on banks' funding costs by regressing the first-differenced dependent variable on the first differenced predicted values of diversification from the first step, as well as lagged values of the dependent variable and the predicted variable of diversification. The second-step equation can be written as:

$$DIV_{it} = \sum_{i=1}^k \rho_i DIV_{it-1} + \sum_{j=1}^7 \vartheta_j Controls_{jt} + \alpha_i + \lambda_t + \mu_{it} \quad (9)$$

RESULTS AND DISCUSSION

Descriptive Statistics

Table 2 presents the descriptive statistics for the variables under study. The sampled banks exhibit relatively low funding costs compared to other developing regions, with a mean of 5.2%. This reflects Indonesia's generally moderate interest rate environment over the study period, shaped by Bank Indonesia's accommodative monetary stance during 2020 to 2021 and a gradual tightening cycle thereafter. Furthermore, the sampled banks display moderate levels of diversification towards non-interest income, as evidenced by the mean RDIV of 41.2% and ARDIV of 44.1%. The HHI for ADIV indicates significant asset-based diversification, with a mean value of 0.534. Conversely, the relatively low value of AADIV (0.178) indicates a higher concentration in interest-earning assets. Lastly, the banks studied show significant variation in financial regulations as shown by the standard deviations of interest rate controls and Basel of 0.500 and 0.485, respectively.

The correlation coefficient matrix (available upon request) reveals low correlations between the study variables, with all coefficients below 0.4, suggesting the absence of multicollinearity issues.

Table 2. Descriptive statistics.

Variable	Obs	Mean	SD	Min	Max
Funding costs	1127	0.052	0.024	0.004	0.148
RDIV	1152	0.412	0.148	0.000	1.000
ARDIV	1148	0.441	0.152	0.000	1.000
ADIV	1089	0.534	0.164	0.170	1.000
AADIV	982	0.178	0.085	0.000	0.420
Interest rate controls	1178	0.482	0.500	0.000	1.000
Basel	1178	0.624	0.485	0.000	1.000
Equity	1048	0.113	0.048	0.000	0.320
Size	1150	14.87	2.14	10.24	21.46
ROA	1052	0.017	0.018	-0.060	0.090
Policy rate	1073	0.056	0.022	0.035	0.077
Inflation	1098	0.042	0.023	0.016	0.086
GDP growth	1178	0.046	0.022	-0.021	0.075
Crisis	1178	0.133	0.340	0.000	1.000

Figure 1 below illustrates the trends in funding costs, revenue diversification, and asset diversification across the four bank ownership categories in Indonesia between 2010 and 2024.



Figure 1: Trends in funding costs, revenue, and asset diversification across bank ownership categories: (a) State-owned commercial banks; (b) Private national banks; (c) Regional development banks; (d) Foreign/joint venture banks.

The Relationship Between Diversification and Banks' Funding Costs

Table 3 displays the regression results for testing hypothesis 1, which examines the negative effect of diversification on banks' funding costs in Indonesia using the fixed effects model. The results for RDIV and ADIV are presented in columns (1) to (2) and (3) to (4), respectively. According to the results in Table 3, revenue diversification has a consistently negative and significant effect on banks' funding costs. These results support hypothesis 1 and align with prior related studies of Shabir et al. (2024) and Addai et al. (2022), suggesting that income diversification enhances bank performance, which ultimately leads to reduced risk and, consequently, a lower cost of capital.

Two possible arguments exist for the negative relationship between revenue diversification and banks' funding costs. Firstly, higher revenue diversification can reduce banks' risk by minimising income volatility (Shabir et al. 2024; Shahriar et al. 2023). As a result, lenders may view such banks as less risky, leading to a reduced premium in their funding costs (Tran & Nguyen 2023). Secondly, diversification of revenue sources can enhance banks' profitability and efficiency through economies of scope under the synergy effect as shown by (Kim et al., 2020; Šeho et al., 2021)(Shahriar et al., 2023). The increased profitability and efficiency may subsequently reduce banks' funding costs, as investors and lenders perceive them as low-risk borrowers (Nguyen et al. 2024). In the Indonesian context, banks that have broadened their fee-based and digital banking income streams have demonstrated notably more stable earnings, consistent with this reasoning.

The results in Table 3 show a statistically significant negative relationship between asset diversification and banks' funding costs, further supporting Hypothesis 1. These findings align with those of Levine et al. (2021), which show that asset diversification reduces funding costs for banks. This is possibly because asset diversification reduces risk by adding assets to banks' portfolios that are imperfectly correlated with existing ones, thereby spreading and minimising potential financial exposure (Ben et al. 2023). Moreover, asset-based diversification enables banks to spread their activities across various industries, potentially reducing the expected costs of financial distress (Shabir et al. 2024). This may result in more stable financial performance for banks, resulting in lower funding costs as the risk to lenders and investors diminishes as shown by Shahriar et al. (2023).

Looking at the control variables, equity has a positive and significant effect on banks' funding costs. This outcome may be expected because an increase in equity reduces banks' return on capital, leading to higher funding costs (Andrieș & Sprincean 2023). The coefficients for ROA are negative and significant, suggesting that higher profitability lowers banks' funding costs. This result is consistent with the finding that profitability lowers funding costs by reducing banks' risk-taking incentives because of increased charter value. As expected, the policy rate has a significant positive effect on banks' cost of funds, consistent with earlier findings by Čehajić and Košak (2021), indicating that an increase in the policy rate leads to higher interest rates for banks' funding. Lastly, inflation has a positive and significant coefficient, confirming earlier studies by Shabir et al. (2024) that

suggest higher inflation rates increase lenders' and investors' required rate of return, resulting in higher banks' funding costs.

Table 3. Diversification impact on funding costs using fixed effects model.

Variables	Sub-variable	Revenue diversification		Asset diversification	
		-1	-2	-3	-4
RDIV	Coeff	-0.018***			
	SE	0.006			
ARDIV	Coeff		-0.019***		
	SE		0.006		
ADIV	Coeff			-0.022***	
	SE			0.006	
AADIV	Coeff				-0.031***
	SE				0.012
Equity	Coeff	0.142***	0.141***	0.138***	0.133***
	SE	0.022	0.022	0.022	0.023
Size	Coeff	0.002	0.002	0.003	0.002
	SE	0.002	0.002	0.002	0.002
ROA	Coeff	-0.124***	-0.124***	-0.139***	-0.218***
	SE	0.041	0.041	0.042	0.045
Policy rate	Coeff	0.216***	0.214***	0.221***	0.278***
	SE	0.016	0.016	0.017	0.019
Inflation	Coeff	0.045***	0.044***	0.046***	0.042***
	SE	0.010	0.010	0.011	0.011
GDP growth	Coeff	-0.019	-0.018	-0.013	-0.033*
	SE	0.021	0.021	0.022	0.022
Crisis	Coeff	0.009	0.009	0.008	0.010
	SE	0.007	0.007	0.007	0.007
Constant	Coeff	0.087***	0.091***	0.066***	0.063**
	SE	0.025	0.025	0.026	0.029
Observations		820	817	759	706
Year fixed effects		Yes	Yes	Yes	Yes
R-squared		0.168	0.171	0.174	0.192

*Note: This table presents the regression results between funding costs and HHI of RDIV, ARDIV, ADIV and AADIV in equations 1, 2, 3 and 4, respectively. The estimates are obtained using the fixed effects model. The control variables include equity, bank size, ROA, policy rate, inflation, GDP growth and crisis. The variables are defined in Table 1. ROA, return on assets; AADIV, adjusted asset diversification; ADIV, asset diversification; ARDIV, adjusted revenue diversification; GDP, gross domestic product; RDIV, revenue diversification; Coeff, coefficient; SE, standard error. **, * and * indicate statistical significance at 1%, 5% and 10%.

Financial Regulations, Diversification, and Banks' Funding Costs

Table 4 presents the second-stage estimation results for testing hypothesis 2, which explores the indirect effects of financial regulations on the relationship between diversification and funding costs, employing the 2SLS method with instrumental variables. The Sargan test and the LM test indicate that the instruments generally meet the relevance and validity conditions, thereby confirming the consistency of the findings. The results in columns (1) to (2) of Table 4 reveal a significantly negative coefficient for the predicted values of revenue diversification, suggesting that financial regulation indirectly lowers banks' funding costs. These findings support hypothesis 2 and are consistent with prior studies of Velasco (2022) and Wang and Lin (2021), which provide evidence that financial regulations encourage banks to pursue diversification strategies. This, in turn, can broaden banks' access to diverse funding sources, ultimately leading to reduced funding costs.

In Indonesia's regulatory environment, OJK's gradual implementation of Basel III capital adequacy standards from 2016 onwards incentivised banks, particularly larger institutions, to explore non-traditional income streams to maintain capital efficiency. Simultaneously, LPS deposit rate caps constrained the ability of banks to attract liabilities through high deposit rates alone, creating further pressure to diversify earnings. This

dual regulatory mechanism operated indirectly, channelling diversification behaviour into lower funding cost outcomes as predicted by hypothesis 2. The insignificant coefficient for ADIV in column (3) may reflect the relatively homogeneous nature of asset portfolios among Indonesian banks, particularly those operating under common OJK sectoral exposure limits that constrain meaningful cross-sector asset diversification (Hunjra et al. 2021).

Table 4. The effect of financial regulations on the relationship between diversification

Variables	Sub-variable	Revenue diversification		Asset diversification	
		-1	-2	-3	-4
RDIV (hat)	Coeff	-0.487*			
	SE	0.253			
ARDIV (hat)	Coeff		-0.412*		
	SE		0.241		
ADIV (hat)	Coeff			0.048	
	SE			0.071	
AADIV (hat)	Coeff				-0.712***
	SE				0.274
Equity	Coeff	0.034	0.072	0.151***	0.101**
	SE	0.076	0.063	0.027	0.042
Size	Coeff	-0.022*	-0.016	0.002	-0.009*
	SE	0.014	0.013	0.002	0.006
ROA	Coeff	-0.091	-0.098	-0.168***	-0.249***
	SE	0.091	0.082	0.047	0.075
Policy rate	Coeff	0.142***	0.108**	0.192***	0.341***
	SE	0.042	0.056	0.017	0.049
Inflation	Coeff	-0.031	-0.019	0.047***	0.038**
	SE	0.045	0.043	0.012	0.018
GDP growth	Coeff	-0.041	-0.067	-0.027	-0.009
	SE	0.047	0.048	0.025	0.039
Crisis	Coeff	0.051**	0.064**	0.027***	0.003
	SE	0.021	0.027	0.009	0.011
Observations		812	808	749	692
Year fixed effects		Yes	Yes	Yes	Yes
LM test p-value		0.124	0.172	0.008	0.007
Sargan test p-value		0.752	0.141	0.631	0.594

*Note: This table presents the second-stage 2SLS regression results, analysing the effect of financial regulations on the relationship between banks' funding costs, and RDIV, ARDIV, ADIV, and AADIV. The control variables include equity, bank size, ROA, policy rate, inflation, GDP growth, and crisis. The variables are defined in Table 1. ROA, return on assets; AADIV, adjusted asset diversification; ADIV, asset diversification; ARDIV, adjusted revenue diversification; GDP, gross domestic product; LM, Lagrange Multiplier; RDIV, revenue diversification; Coeff, coefficient; SE, standard error. **, ** and * indicate statistical significance at 1%, 5% and 10%.

Robustness Check

As indicated earlier, this article employs the GMM estimator to verify the robustness of the baseline results. Table 5 presents the GMM results. The insignificant AR(2) test values indicate the absence of second-order autocorrelation. Similarly, the Sargan test provides evidence that the lagged values of revenue and asset diversification are valid instruments across most of the estimation models. The lagged dependent variables are highly significant, confirming the persistence of funding costs, hence supporting the use of the dynamic model. Overall, the GMM results in Table 5 largely align with the findings from the baseline models, confirming that diversification reduces banks' funding costs. Lastly, the lagged coefficients for revenue and asset diversification (available upon request) consistently remain negative and significant, further confirming that diversification lowers banks' funding costs in Indonesia.

Table 5: Revenue and asset diversification effect on banks' funding costs using GMM.

Variables	Sub-variable	Revenue diversification		Asset diversification	
		-1	-2	-3	-4
L. Funding costs	Coeff	0.548***	0.552***	0.586***	0.547***
	SE	0.015	0.015	0.017	0.017
RDIV	Coeff	-0.009**			
	SE	0.004			
ARDIV	Coeff		-0.012***		
	SE		0.004		
ADIV	Coeff			-0.010***	
	SE			0.003	
AADIV	Coeff				-0.026***
	SE				0.007
Equity	Coeff	0.182***	0.175***	0.163***	0.162***
	SE	0.018	0.018	0.017	0.018
Size	Coeff	0.001***	0.001***	0.001*	0.000
	SE	0.000	0.000	0.000	0.000
ROA	Coeff	-0.048	-0.041	-0.063*	-0.096***
	SE	0.031	0.031	0.033	0.034
Policy rate	Coeff	0.122***	0.107***	0.112***	0.139***
	SE	0.013	0.013	0.014	0.010
Inflation	Coeff	0.038***	0.051***	0.054***	0.057***
	SE	0.005	0.005	0.005	0.005
GDP growth	Coeff	-0.031***	-0.017*	-0.063***	-0.038***
	SE	0.010	0.010	0.012	0.011
Crisis	Coeff	0.007***	0.016***	0.017***	-0.003***
	SE	0.001	0.001	0.002	0.001
Observations		716	714	664	617
Year fixed effects		Yes	Yes	Yes	Yes
AR2		0.337	0.358	0.429	0.258
Sargan test p-value		0.631	0.594	0.914	0.652

*Note: This table shows the GMM regression results between banks' funding costs, RDIV, ARDIV, ADIV, and AADIV. The control variables include equity, bank size, ROA, policy rate, inflation, GDP growth, and crisis. The variables are defined in Table 1. ROA, return on assets; AADIV, adjusted asset diversification; ADIV, asset diversification; ARDIV, adjusted revenue diversification; GDP, gross domestic product; LM, Lagrange multiplier; AR(2), Arellano-Bond test; RDIV, revenue diversification; Coeff, coefficient; SE, standard error. **, ** and * indicate statistical significance at 1%, 5% and 10%.

The Effect of Bank Size

Studies (Tran et al., 2024) suggest that the relationship between diversification, financial regulations, and funding costs can vary significantly across banks of varying sizes. Large banks typically have greater resources and market access, enabling them to diversify risks across a broader range of assets and efficiently navigate complex financial regulations (Shabir et al. 2024). This can enhance the benefits of diversification in lowering funding costs. In contrast, smaller banks often have limited resources and face relatively higher compliance costs, which can reduce the effectiveness of diversification and increase the sensitivity of funding costs to regulatory pressures (Andrieş & Sprincean 2023).

Accordingly, to investigate the possibility that large banks benefit from cheaper funding costs, this study further examines the effect of diversification on banks' funding costs and the indirect role of financial regulations across different levels of bank size by re-estimating equations (1) to (9) for small and large banks. In this article, banks are classified as small if their total assets fall below the 50th percentile of the total assets of Indonesian commercial banks in a given year, and as large if their total assets are at or above the 50th percentile following (Kim et al., 2020). The results are presented in Table 6. For large banks, the coefficient for

revenue diversification remains significantly negative as shown in columns (1) to (2). However, this significant effect is considerably weaker for small banks as indicated in columns (7) to (8).

These findings support Huynh and Dang (2022), indicating that large banks are more stable, which can significantly lower their funding costs. Columns (3) to (4) and (9) to (10) show no significant difference in the indirect effect of financial regulation on banks' funding costs for small and large banks contrary to the results shown in Table 4. A possible argument for this outcome is that banks, regardless of size, are subject to a uniform OJK regulatory framework. Thus, regulations may not provide differential funding cost advantages based on diversification (Velasco 2022). Furthermore, large banks possess a significant advantage in managing operating leverage associated with shifts towards non-interest income, attributed to their access to resources as shown by Shabir et al. (2024). The results indicate no notable difference between asset diversification and banks' funding costs for the two subsamples. This is possibly because OJK's sectoral credit concentration limits apply uniformly across bank sizes, causing banks regardless of size to hold broadly similar asset exposures, thereby resulting in minimal differentiation in the impact of asset diversification on banks' funding costs (Adesina 2021).

Table 6: Effects of size on diversification and banks' funding costs relationship.

Variable	Sub-var	Panel A: Small banks						Panel B: Large banks					
		FE		2SLS		GMM		FE		2SLS		GMM	
		1	2	3	4	5	6	7	8	9	10	11	12
Revenue diversification													
L. Funding costs	Coeff					0.509***	0.546***					0.551***	0.554***
	SE					0.030	0.030					0.010	0.008
RDIV	Coeff	-0.011*		-0.099		-0.004		-0.021** *		-0.148		-0.029** *	
	SE	0.007		0.158		0.006		0.007		0.134		0.002	
ARDIV	Coeff		-0.011*		-0.028		-0.004		-0.022** *		-0.318		-0.026** *
	SE		0.008		0.132		0.006		0.007		0.276		0.003
Controls		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Obs		445	443	439	436	382	381	375	374	373	372	334	333
R-squared		0.094	0.092					0.261	0.264				
Year FE		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
LM p-val				0.258	0.169					0.139	0.406		
AR2						0.314	0.368					0.421	0.430
Sargan p						0.151	0.241					0.999	0.998
Asset diversification													
L. Funding costs	Coeff					0.601***	0.516***					0.591***	0.571***
	SE					0.029	0.030					0.006	0.010
ADIV	Coeff	-0.025** *		0.519		-0.011** *		-0.029** *		-0.161*		-0.004**	
	SE	0.006		0.358		0.004		0.006		0.086		0.002	
AADIV	Coeff		-0.010		-0.449**		-0.023**		-0.047** *		-0.436**		-0.024** *
	SE		0.017		0.181		0.011		0.015		0.328		0.003
Controls		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Obs		406	357	397	350	350	307	354	347	353	346	314	310
R-squared		0.094	0.145					0.272	0.274				
Year FE		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
LM p-val				0.261	0.001					0.014	0.311		
AR2						0.871	0.126					0.388	0.448
Sargan p						0.330	0.125					0.998	0.997

*Note: This table reports the regression results of the relationship between diversification and banks' funding costs for small and large bank subsamples using the fixed effects model, 2SLS, and two-step system GMM. The coefficients of the control variables, which include equity, bank size, ROA, policy rate, inflation, GDP growth, and crisis variables, and constants have been removed to save on space. The variables are defined in Table 1. ROA, return on assets; AADIV, adjusted asset diversification; ADIV, asset diversification; ARDIV, adjusted revenue diversification; RDIV, revenue diversification; GDP, gross domestic product; LM, Lagrange multiplier; AR(2), Arellano-bond test;

2SLS, two-stage least squares; GMM, generalised method of moments; FE, fixed effects model; Coeff, coefficient; SE, standard error. **, * and * indicate statistical significance at 1%, 5% and 10%, respectively.

The Effect of Ownership Type

Table 7 displays the results of re-estimating equations (5) to (9) for a sub-sample of domestic and foreign or joint venture banks in the context of revenue and asset diversification. The results reveal that a shift towards non-interest income activities has an insignificant effect on funding costs for domestic banks, but significantly and negatively influences funding costs for foreign or joint venture banks, as shown in columns (1) to (2) and (7) to (8), respectively. These findings are in line with Wang (2023), indicating that banks with broader geographical reach and institutional connections gain from economies of scale and enhanced financial access. The international parentage of foreign banks in Indonesia facilitates access to group-level liquidity facilities and cross-border capital markets, amplifying the positive effect of diversification on funding cost reduction.

Regarding the effects of asset diversification on funding costs, the findings from Panels A and B of Table 7 do not exhibit significant differences between the two groups, suggesting that OJK's standardised credit concentration guidelines constrain differential asset diversification strategies regardless of bank ownership type. Furthermore, the results show a more significant indirect inverse effect of financial regulation on funding costs for foreign or joint venture banks compared to domestic banks, suggesting that the indirect effect of financial regulation on funding costs varies with banks' ownership type. This variation is likely because investors perceive foreign or joint venture banks as less risky, given their operation under multiple regulatory environments and international parent oversight, which can significantly reduce their funding costs (Poshakwale et al. 2020). Furthermore, banks with broader institutional connections can take advantage of regulatory environments to access cheaper funding sources (Avdjiev, Aysun & Tseng 2022).

Table 7: Effects Of Ownership Type on Diversification and Banks' Funding Costs Relationship

Variable	Sub-var	Panel A: Domestic banks						Panel B: Foreign/JV banks						
		FE		2SLS		GMM		FE		2SLS		GMM		
		1	2	3	4	5	6	7	8	9	10	11	12	
Revenue diversification														
L. Funding costs	Coeff					0.528***	0.531***					0.504***	0.487***	
	SE					0.020	0.019					0.020	0.020	
RDIV	Coeff	-0.007		0.194		0.001		-0.024**	*	-0.254**		-0.021**	*	
	SE	0.007		0.348		0.002		0.006		0.113		0.005		
ARDIV	Coeff		-0.009		0.972		-0.003		-0.024**	*	-0.257**		-0.018**	*
	SE		0.007		1.498		0.003		0.006		0.112		0.004	
Controls		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Obs		366	365	362	361	322	321	454	452	450	447	394	393	
R-squared		0.209	0.210					0.156	0.157					
Year FE		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
LM p-val				0.672	0.802					0.014	0.013			
AR2						0.263	0.265					0.578	0.590	
Sargan p						0.996	0.995					0.997	0.998	
Asset diversification														
L. Funding costs	Coeff					0.573***	0.544***					0.517***	0.462***	
	SE					0.016	0.014					0.022	0.019	
ADIV	Coeff	-0.044**	*	0.201*		-0.007**	*	-0.010*		-0.189		-0.009**	*	
	SE	0.007		0.112		0.003		0.006		0.136		0.004		
AADIV	Coeff		-0.033**		-0.948		-0.031**	*	-0.019		-0.718**		-0.027**	*
	SE		0.016		0.612		0.004		0.014		0.315		0.008	
Controls		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Obs		337	318	332	313	297	281	421	385	417	381	367	336	
R-squared		0.231	0.249					0.150	0.183					
Year FE		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
LM p-val				0.010	0.231					0.109	0.024			
AR2						0.354	0.149					0.876	0.593	
Sargan p						0.997	0.997					0.998	0.998	

*Note: This table shows the regression results between funding costs and HHI of RDIV, ARDIV, ADIV, and AADIV. Equations (1) to (6) in Panel A have been estimated using a subsample of domestic banks, while equations (7) to (12) in Panel B have been estimated using a subsample of foreign and joint venture banks. The coefficients for the control variables and constants have been eliminated to save on space. The variables are defined as per Table 1. ROA, return on assets; AADIV, adjusted asset diversification; ADIV, asset diversification; ARDIV, adjusted revenue diversification; GDP, gross domestic product; LM, Lagrange multiplier; AR(2), Arellano-bond test; 2SLS, two-stage

CONCLUSION

This article examines the effect of revenue and asset diversification on banks' funding costs and the potential indirect effect of financial regulations using both static and dynamic panel data techniques on 87 commercial banks in Indonesia from 2010 to 2024. Using alternative revenue and asset diversification measures, the study results show strong evidence that increased diversification reduces banks' overall funding costs in Indonesia. Importantly, the study finds that the negative effect is more pronounced for large banks. The results also indicate that financial regulation indirectly reduces banks' funding costs via revenue diversification. Notably, this indirect influence is more significant for foreign and joint venture banks than for domestic banks.

The findings of this study provide important implications for policymakers, regulators, bankers, and investors. Firstly, policymakers should formulate and implement policies that incentivise banks to strategically diversify their revenue streams and asset portfolios. Such strategic diversification can be instrumental in reducing banks' funding costs. Secondly, regulators, particularly OJK, should consider progressively enhancing minimum capital requirements to stimulate diversification in banking, particularly for banks with foreign or multi-institutional presence. This can be implemented gradually or through a tiered approach to minimise disruptions to credit supply. Bank managers, especially those overseeing large and foreign or joint venture banks, should proactively explore diversification strategies to optimise their funding structure cost-efficiently. Lastly, investors should target large foreign or joint venture banks in Indonesia, as increased diversification and more stringent financial regulations significantly lower their funding costs, potentially enhancing investment returns.

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