Influence of Information Technology Investment on Indonesian Bank Profitability with Size Moderation

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Abstract

This research aims to explore the influence of information technology investment on bank profitability in Indonesia, with firm size as a moderating variable. This research is an associative research with quantitative approach. The methodology employed is panel data regression analysis, utilizing a purposive sampling technique, and a sample of 24 banks listed on the Indonesian Stock Exchange from 2019 to 2023. The analyzed data includes information on information technology investments, profitability measured by return on assets and return on equity, and firm size represented by total assets. The findings reveal that information technology investment positively and significantly affects bank profitability in terms of both return on assets and return on equity. However, the hypothesis stating that firm size strengthens the influence of information technology investment on return on assets was rejected, indicating that there is a time lag in realizing the full benefits of technology investments on asset efficiency. Conversely, the hypothesis that firm size strengthens the impact of information technology investment on return on equity was accepted, suggesting that larger banks can leverage technology investments more effectively to enhance their profitability. These findings hold important applications for bank managers in planning technology investment strategies, particularly in the context of improving operational efficiency and competitiveness in an increasingly digital banking industry. This study also contributes to the literature on information technology investment and financial performance in the banking sector.

Keyword: information technology investment; return on assets; return on equity; bank size; agency theory; contingency theory

1. Introduction

The banking sector is one of many industries influenced by the Fourth Industrial Revolution. In banking operations, information technology (IT) is increasingly utilized, ranging from digital payments, online banking services, to customer data analytics. Banks today are more focused on digital transformation compared to several decades ago, when they primarily invested in physical assets and opened new branches. This shift is evident in the rising usage of digital banking services and the automation of processes. According to Timothy Utama, Director of Information Technology at Bank Mandiri, the number of users of Bank Mandiri's digital transaction services reached up to 21 million in 2023, growing by 55% year-on-year (Lewokeda, 2023). Additionally, several sources indicate that banks in Indonesia have increased their capital expenditures (CAPEX) for information technology. For example, Bank Mandiri invested IDR 8 trillion, and Bank BCA invested IDR 2 trillion in IT since 2021 (Burhan, 2024).

The COVID-19 pandemic emerged as a pivotal moment, propelling Indonesia's banking sector toward an era of rapid digital innovation. The government's social distancing mandates served as a catalyst, compelling people to embrace digital banking as a primary means of managing their transactions, transforming habits related to digital transactions that continue to this day. As report by Bank Indonesia (2022), digital banking transactions increased by 62,82% year-on-year, electronic money transaction values rose by 66,65% year-on-year, nominal transactions via QRIS surged by 290%, and ATM card transaction values grew by 14,39% year-on-year, totally approximately IDR 711,2 trillion during 2022. This increase not only benefits consumers with easier access and efficiency, but also advantages banking institutions. According to Mutiasari (2020), digitalization benefits banking institutions by automating processes, reducing operational costs, and utilizing real-time data analytics. Thus, digitalization has become not just a short-term solution during the pandemic, but a foundation for long-term evolution within Indonesia's banking industry. Therefore, this research focuses on data collection over the period from 2019 to 2023.

Prior inquiries have underscored the interplay between information technology (IT) investment and the efficacy of a company performance, ranging from telecommunications to banking firms. Several studies found that IT investment can enhance company performance (Yudistira et al., 2023; Purwanto et al., 2022; Rismadewi et al., 2023; Ningrum et al., 2023; Hadi et al., 2023; Pan et al., 2020; Singhal & Jain, 2020: Hamdan et al., 2022; Farliana, 2019). Additionally, Chhaidar et al. (2023) suggested that IT investment significantly drives bank profitability, with the size of the bank influencing the dynamics of this relationship. In line with this, several other studies also show that firm size influences the extent to which IT investment positively affects financial performance (Pan et al., 2020; Karim & Qamruzzaman, 2022; Roy & Thangaraj, 2020; Hasan et al., 2020).

However, the influence of IT investment on a company's financial performance is not always linear. A study by Wibowo et al. (2020) concluded that IT investment does not exhibit a meaningful connection with financial measures like ROA, ROE, and EPS. Additional sources also suggest that IT investment does not play a substantial role in shaping a company's financial performance (Ramadhani, 2021; Ludipa, 2018). Other studies propose that the influence of IT investment on company performance unfolds gradually and may not be instantly noticeable. As noted by Campbell (2012), the realization of IT investment benefits

on company performance generally unfolds over a period of three to four years. The divergence in findings from previous studies underscores the multifaceted and nuanced connection between IT investment and company performance (Khallaf et al., 2017). Findings may be influenced by factors such as research methodology, data used, and industry characteristics (Kohli & Devaraj, 2003). For instance, research conducted by Szász et al. (2023) on manufacturing companies shows that firm size has yet to effectively moderate IT investment on company performance.

Thus, this study endeavors to uncover the relationship between IT investment and the financial outcomes of companies operating in the banking sector, as previous findings have shown varied results. Additionally, there is still a research gap regarding updated analyses of the banking sector from 2019 to 2023, the use of firm size as moderating variable, and the underlying contingency theory of this moderating variable. The importance of this study lies in its reflection amid massive digitalization trends and the continuous increase in budget allocation for information technology (IT) by banking companies). Thus, the author conducts research entitled "Influence of Information Technology Investment on Indonesian Bank Profitability with Size Moderation."

2. Literature Review

2.1 Information Technology (IT) Investment

Investments in IT reflect the strategic allocation of assets–hardware, software, networks, and HR–designed to manage information systems, streamline operations, and drive the company's business objectives (Laudon & Laudon, 2017). According to Schniederjans et al. (2010), IT investment encompasses the provision of all resources necessary to manage information systems, such as hardware, software, and HR. Bendianishvili (2022) adds that IT investment is a broad term that includes various categories, including infrastructure, information systems, transactions, and strategic IT initiatives.

Many companies are beginning to consider utilizing IT because it is believed to enhance competitive advantage, reduce production costs, improve service quality, accelerate goal achievement, increase revenue, and enhance employee performance (Aldalayeen et al., 2013). However, without good governance, IT investment has the potential to pose risks of declining financial performance for the company. This occurrence is referred to as the IT productivity paradox, which occurs when IT investments do not always yield optimal results for the company (Brynjolfsson & Hitt, 2000).

2.2 Return on Assets (ROA)

ROA serves as profitability metric that reflects the degree to which a company transforms its asset investments into profits (Kasmir, 2014). This achieved by dividing post-tax net income by the company's total assets. This ratio reflects the proficiency of management in leveraging the company's resources and assets to achieve sustainable profit generation (Penman, 2010). Conversely, a low ROA suggests that the company may not be using its assets optimally (Gitman & Zutter, 2015). According to Molyneux and Thornton (1992), ROA is a key performance indicator in the banking sector, as banks heavily rely on their assets to generate income from loans, investments, and other financial products. Therefore, ROA serves not only as a benchmark for profitability, but also for operational efficiency.

2.3 Return on Equity (ROE)

ROE serves as a metric reflecting how efficiently a company transforms its equity capital into net income after taxes, showcasing management's strategic use of resources (Kasmir, 2014). ROE is determined by the proportion of net income after tax relative to the equity provided by shareholders, which represents the return rate shareholders earn on their investment in the company (Ross et al., 2023). A higher ROE value signifies better company performance in generating profits for shareholders, indicating that the company is capable of utilizing equity capital more efficiently (Kasmir, 2016).

Ross et al. (2023) describe ROE as a "bottom-line measure of performance", an important tool for assessing the extent to which a company achieves it goals of providing profits to shareholders. In the context of the banking industry, Mishkin (2016) emphasizes that ROE is a key indicator used by banks to demonstrate their ability to generate profits from available capital. ROE also serves as a benchmark for interbank performance and is used to evaluate how banks manage capital risk and enhance profitability through effective capital utilization. Therefore, ROE is not solely used to evaluate how effectively a company generates profits from its equity. This ratio is highly relevant in the analysis of banking profitability, as banks must be able to maximize returns on equity capital without neglecting the inherent risk management in their operations.

2.4 Firm Size

The size of a firm is represented by its total assets, with the values transformed into natural logarithms to facilitate meaningful analysis (Bates et al., 2009). Selection of total assets as an indicator of firm size stems from their ability to reflect a company's resource base and its inherent potential for generating profits (Dang et al., 2013). Firm size is closely related to the company's efficiency and sustainability (Magerakis et al., 2020). As noted by Beck et al. (2005), the size of a firm profoundly impacts its capacity to explore and achieve growth opportunities

2.5 Agency Theory

Jensen and Meckling's agency theory (1976) delves into the intricate interplay between owners and managers, revealing tensions rooted in divergent interests and imbalances information (Jensen et al., 1976). This conflict emerges when managers, acting as agents, make decisions that serve their personal interests instead of focusing on the broader goals of the company's owners. The information gap between the principal and the agent can lead to poor decision-making, which in turn generates agency costs for the organization.

In a business environment, agency theory is frequently applied to analyze tensions between shareholders (principals) and managers (agents), particularly in the management of major investments in areas such as R&D and IT. Zona (2016) suggests that agency models can help explain managerial opportunism, where managers may make decisions that prioritize personal interests over those of the company. This notion extends to IT investments, which seek to alleviate agency conflicts by fostering transparency and reinforcing a sense of accountability in corporate governance practices.

According to Moloi and Marwala (2020), investments in information technology are highly relevant in the banking sector, as they can mitigate agency issues by improving information flow and reducing information asymmetry between principals and agents. Additionally, Laudon and Laudon (2017) state that IT investments not only help reduce agency

costs by minimizing overall management expenses but also provide opportunities for companies to improve financial performance through enhanced operational efficiency. With information technology, companies can reduce reliance on human roles in business processes and create more effective control mechanisms to mitigate conflicts of interest between principals and agents.

2.6 Contingency Theory

Contingency theory, developed by various scholars such as D.S. Pugh and the Aston Group in the 1960s, emphasizes that no single approach can be universally applied to direct a company or make decisions. Organizational effectiveness is influenced by the alignment between internal characteristics and external contingency factors within which the organization operates (Pugh et al., 1968; Donaldson, 2011). This theory explains that the effectiveness of investment decisions, including information technology (IT) investments, is highly dependent on the environmental context and organizational characteristics, such as company size, organizational structure, and market complexity.

According to Damanpour (2010), larger companies tend to be more willing to invest in R&D and information technology, as they have the capacity to bear greater risks compared to smaller companies. This aligns with research by Muhammad et al. (2022), which is found that company size significantly influences a firm's ability to invest in R&D, with larger companies being better able to manage risks and capitalize on the opportunities from resulting innovations. On the other hand, Szász et al. (2023) reveal that company size also affects IT investment implementation, though the impact on the performance is not always significant, depending on how the company aligns its IT strategy with its environmental conditions.

This study adopts contingency theory to analyze how company size shapes the effectiveness of IT investments, acting as either a catalyst or a barrier in the investment decision-making process. Larger companies, with stronger resources, tend to have a greater capacity to leverage IT investments to support growth and improve financial performance. Conversely, smaller companies may face constraints in terms of resources and managerial capabilities, requiring that IT investment strategies be adapted to the internal and external conditions they face in order to achieve the desired outcomes effectively.

3. Material and Method

3.1 Design Study

A quantitative methodology is employed as the foundation for this research, grounded in positivist philosophy, conducted on a predetermined population or sample, collected using research instruments, and analyzed quantitatively to test hypotheses. Classified as associative research, this study seeks to uncover the dynamics of influence and relationships among multiple variables.

This research draws its sample from the banking sector, including 47 companies listed on the IDX (Indonesian Stock Exchange) over the period of 2019 to 2023. The research employs purposive sampling, a method that involves selecting samples according to specific criteria tailored to the research goals. The sample criteria are outlined as follows:

1. Banking companies included in the IDX listings between 2019 and 2023.
2. Firms in the banking sector that adhered to a consistent reporting schedule, publishing financial and annual reports with a December 31 year-end during the study period.

3. Companies that shared detailed data on software and hardware, aligning with the study's focus.
4. Organizations that avoided financial losses during 2019–2023, ensuring data integrity by avoiding outlier effects.

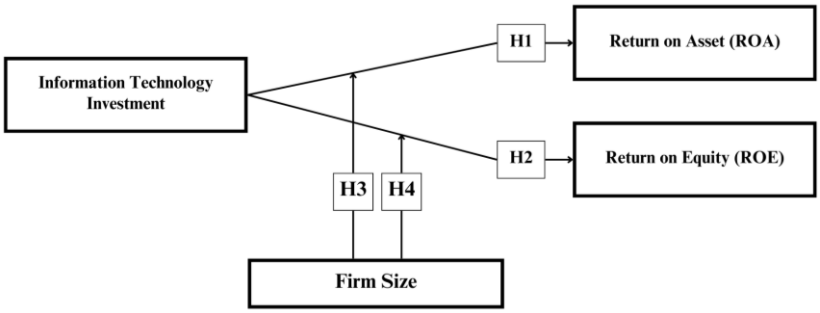
According to these criteria, the sample for this study includes 24 banking sector companies.

Secondary data forms the basis of this research, comprising annual reports and financial statements from 2019 to 2023, retrieved from banking sector entities listed on the IDX using the idx.co.id website. Additional data were retrieved from the website stockbit.com. This study applies the documentation method for data collection, drawing from the list of companies on the IDX and accessing their annual reports and financial statements via idx.co.id for the 2019–2023 timeframe.

3.2 Data Analysis

The data obtained was analyzed using a panel data regression model, with Eviews software serving as the analytical tool. Before performing the panel data regression analysis, the data went through several steps, including transformation if needed, selection of the regression model, tests for classical assumptions, moderation variable tests, and hypothesis testing.

Figure 1. Research Model



4. Result

4.1 Model Selection Tests

Through the application of the Chow test, Hausman test, and Lagrange Multiplier (LM) test, this study sought to determine the estimation model that best suited the data, selecting from the CEM, FEM, and REM frameworks.

4.1.1 Chow Test

The initial analysis involves using a Chow test to discern whether the CEM or FEM is the superior model, guided by a 0,05 significance threshold. The FEM is selected if the probability is below 0,05, otherwise, the CEM is chosen.

For structural model I and structural model II, the Chow test yielded probability values of 0,0000, well below the 0,05 significance threshold. This outcome signifies that the FEM is the optimal model, prompting the continuation of analysis with the Hausman test.

4.1.2 Hausman Test

The Hausman test aims to ascertain whether the FEM or FEM is more suitable. If the probability value is under 0,05, FEM is selected, otherwise, REM is deemed the better option.

According to the results of the Hausman test for Structural Model I and Structural Model II, the probability values obtained were 0.0636 and 0.6886, both of which are greater than 0.05. This indicates that the REM is selected as the best model, and the analysis continues with the Lagrange Multiplier (LM) test.

4.1.3 LM Test

LM test evaluates whether the CEM or REM is more appropriate. If the probability value is under 0,05, REM is chosen, otherwise, CEM is deemed better.

Based on the results of the LM test for Structural Model I and Structural Model II, the probability values were 0.0000 and 0.0000, both of which are less than 0.05. This confirms that the REM is the best model.

4.2 Classical Assumptions Test

The REM was determined to be the best model for both structural models in this study. Since the REM was selected, classical assumption tests for the panel data regression models are not necessary. This is because the REM is part of the Generalized Least Square (GLS) estimation method (Gujarati & Porter, 2009; Badawi et al., 2022).

4.3 Hypothesis Test

Dharma et al. (2020:107–108) outlined several stages in moderation variable analysis, which include:

1. Examining the influence of the independent variable on the dependent variable using regression analysis.
2. Analyzing how the independent and moderating variables collectively influence the dependent variable via regression.
3. Examining the interplay of the independent variable, moderating variable, and their interaction on the dependent variable through regression.

4.3.1 T Test

The findings from the regression equation analysis of structural model I and structural model II are outlined in Tables 1 and 2:

Table 1. Regression Results of Structural Model I

Dependent Variable: ROA

Method: Panel EGLS (Cross-section random effects)

Date: 10/24/24 Time: 18:51

Sample: 2019 2023

Periods included: 5

Cross-sections included: 24

Total panel (balanced) observations: 120

Swamy and Arora estimator of component variances

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.031495	0.020453	-1.539837	0.1263
X1	0.001815	0.000802	2.264469	0.0254

The structural model equation I, as inferred from the table above, is expressed as follows:

ROA = -0,031495 + 0,001815X1

Here is the explanation for the regression equation of Structural Model I:

1. The coefficient of 0,001815 for variable X (IT Investment) signifies that each 1 unit increase in IT investment contributes to a 0,001815 unit rise in ROA, under the assumption that other factors remain fixed
2. The p-value for the variable X (IT Investment) is 0.0254, which is less than 0.05, indicating that the variable X (IT Investment) is statistically significant at the 5% significance level. In other words, IT investment significantly affects ROA, and thus H1 is accepted.

Table 2. Regression Results of Structural Model II

Dependent Variable: ROE

Method: Panel EGLS (Cross-section random effects)

Date: 10/24/24 Time: 19:14

Sample: 2019 2023

Periods included: 5

Cross-sections included: 24

Total panel (balanced) observations: 120

Swamy and Arora estimator of component variances

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.278554	0.070346	-3.959763	0.0001
X1	0.014098	0.002770	5.089646	0.0000

The structural model equation II, as inferred from the table above, is expressed as follows:

ROE = -0,278554 + 0,014098X1

Here is the explanation for the regression equation of Structural Model II:

1. The coefficient of 0,014098 for variable X (IT Investment) signifies that each 1 unit increase in IT investment contributes to a 0,014098 unit growth in ROE, assuming all others factor are unchanged.
2. The p-value for the variable X (IT Investment) is 0.0000, which is less than 0.05, indicating that the variable X (IT Investment) is statistically significant at the 5% significance level. In other words, IT investment significantly affects ROE, and thus H2 is accepted.

4.3.2 Moderated Regression Analysis

The second stage is to regress the independent variables and moderating variables against the dependent variable, with the following explanation:

Table 3. Results of the Regression for Independent and Moderating Variables in Structural Model I

Dependent Variable: ROA
Method: Panel EGLS (Cross-section random effects)
Date: 10/24/24 Time: 19:03
Sample: 2019 2023
Periods included: 5
Cross-sections included: 24
Total panel (balanced) observations: 120
Swamy and Arora estimator of component variances

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.048951	0.037411	-1.308461	0.1933
X1	0.001501	0.000973	1.542531	0.1256
Z	0.000788	0.001435	0.549314	0.5838

The structural model equation I, as inferred from the table above, is expressed as follows:

ROA = -0,048951 + 0,001501X1 + 0,000788Z

With a t-statistic of 0,549314 and a p-value of 0,5838–exceeding the 0,05 significance level–variable Z (Firm Size) is found to have no significant effect on ROA within this model.

Table 4. Results of the Regression for Independent and Moderating Variables in Structural Model II

Dependent Variable: ROE
Method: Panel EGLS (Cross-section random effects)
Date: 10/24/24 Time: 19:17
Sample: 2019 2023
Periods included: 5
Cross-sections included: 24
Total panel (balanced) observations: 120
Swamy and Arora estimator of component variances

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.529371	0.116167	-4.556975	0.0000
X1	0.005741	0.004169	1.377072	0.1711
Z	0.014345	0.005430	2.641689	0.0094

The structural model equation II, as inferred from the table above, is expressed as follows:

ROE = -0,529371 + 0,005741X1 + 0,014345Z

With a t-statistic of 2,641689 and a p-value of 0,0094, which is less than 0,05, the results show that variable Z (Firm Size) has a significant impact on ROE in this model.

The next step is to regress the independent variable, the moderating variable, and the interaction variable against the dependent variable, with the following explanation:

Table 5. Regression Results of Independent Variables, Moderation, and Interaction of Structural Model I

Dependent Variable: ROA

Method: Panel EGLS (Cross-section random effects)

Date: 10/24/24 Time: 19:08

Sample: 2019 2023

Periods included: 5

Cross-sections included: 24

Total panel (balanced) observations: 120

Swamy and Arora estimator of component variances

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.243652	0.296530	0.821678	0.4129
X1	-0.010610	0.012103	-0.876643	0.3825
Z	-0.008411	0.009377	-0.897036	0.3716
X1Z	0.000379	0.000378	1.001673	0.3186

The structural model equation I, as inferred from the table above, is expressed as follows:

ROA = 0,243652 - 0,010610X1 - 0,008411Z + 0,000379X1*Z

Here is the explanation for the regression equation of Structural Model I:

1. The Interaction Variable (X1Z) has a t-statistic value of 1.001673 with a p-value of 0.3186, which is greater than 0.05. This allows us to conclude that the variable Z (Firm Size) does not significantly moderate the effect of variable X (IT Investment) on the variable ROA, and thus H3 is rejected.
2. The variable Z (Firm Size) in the Structural Model I equation is classified as a Homologizer Moderator or not a moderator, as evidenced by the lack of a significant effect between the variable Z (Firm Size) and ROE, as well as the lack of a significant effect between the interaction variable (X1*Z) and ROE.

Table 6. Regression Results of Independent Variables, Moderation, and Interaction of Structural Model II

Dependent Variable: ROE

Method: Panel EGLS (Cross-section random effects)

Date: 10/24/24 Time: 19:22

Sample: 2019 2023

Periods included: 5

Cross-sections included: 24

Total panel (balanced) observations: 120

Swamy and Arora estimator of component variances

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	2.508168	1.112004	2.255538	0.0260
X1	-0.115594	0.044398	-2.603568	0.0104
Z	-0.081461	0.035202	-2.314093	0.0224
X1Z	0.003811	0.001387	2.748751	0.0069

The structural model equation II, as inferred from the table above, is expressed as follows:

ROE = 2,508168 - 0,115594X1 - 0,081461Z + 0,003811X1*Z

Here is the explanation for the regression equation of Structural Model II:

1. The t-statistic value of 2,748751 and p-value of 0,0069 for the interaction variable (X*Z) suggest that variable Z (Firm Size) plays a significant moderating role in the relationship between X (IT Investment) and ROE, supporting H4.
2. Within structural model I, variable Z (Firm Size) is identified as a Quasi Moderator due to its significant association with Y2 (ROE) and the notable interaction between X*Z and Y2 (ROE).

4.3.3 F test

The following are the results of the F test for structural models I and II:

Table 7. F Test Results of Structural Model I

R-squared	0.052897
Adjusted R-squared	0.028403
S.E. of regression	0.005257
F-statistic	2.159584
Prob(F-statistic)	0.096561

Based on the table above, the f-statistic value is 2.159584 with a prob(f-statistic) value of 0.096561. This allows us to conclude that the variables X (IT Investment) and Z (Firm Size) do not have a significant simultaneous effect on the variable ROA, and thus H5 is rejected. Additionally, the adjusted R-squared value is 2.8 percent.

Table 8. F Test Results of Structural Model II

R-squared	0.257791
Adjusted R-squared	0.238596
S.E. of regression	0.022852
F-statistic	13.43006
Prob(F-statistic)	0.000000

Based on the table above, the f-statistic value is 13.43006 with a prob(f-statistic) value of 0.0000. This allows us to conclude that the variables X (IT Investment) and Z (Firm Size) have a significant simultaneous effect on the variable ROE, and thus H6 is accepted. Additionally, the adjusted R-squared value is 23.8%.

5. Discussion

5.1 Effect of IT Investment on ROA

The hypothesis test, with a t-statistic of 2,264469 and a p-value of 0,0254 for the IT investment variable (X), supports the rejection of H_0 and the acceptance of H_a, showing that IT investment significantly affects ROA within Indonesian banking sector companies.

These results are consistent with studies conducted by Andriani (2019), Farliana (2019), Roy et al. (2020), Singhal et al. (2020), Hamdan et al. (2022), and Hadi et al. (2023), which indicate that IT investment can create operational efficiencies by reducing agency costs and increasing profitability. In the context of agency theory, the relationship between managers (agents) and shareholders (principals) often leads to agency costs due to differing interests between the two parties. IT investments, such as automation systems and integrated data processing, can help reduce agency costs by improving transparency and the accuracy of information between agents and principals. Information technology allows shareholders to monitor management performance more effectively and reduces the risk of information asymmetry, which is a source of conflict in agency relationships.

5.2 Effect of IT Investment on ROE

The hypothesis test, showing a t-statistic of 5,089646 and a p-value of 0,0000 for the IT investment variable (X), supports the rejection of H_0 and acceptance of H_a. This highlights the substantial influence of IT investment on ROE in the Indonesian banking sector.

These results are consistent with studies conducted by Farliana (2019), Roy & Thangaraj (2020), Ramadhani (2021), and Hadi et al. (2023), which indicate that IT investment can enhance shareholder returns due to operational efficiencies. IT investment allows companies to reduce operational costs that would otherwise be higher if performed conventionally. With lower operational costs and increased productivity, the company's net profit rises, thereby directly contributing to the increase in return on equity (ROE).

5.3 Effect of IT Investment on ROA with Firm Size as a Moderating Variable

Based on the results of the hypothesis test, it is known that the interaction variable between IT investment and firm size has a t-statistic value of 1.001673 and a p-value of 0.3185, thus failing to reject H0. In other words, the firm size (Z) variable does not significantly moderate the effect of IT investment on return on assets (ROA).

These results contradict the research conducted by Chhaidar et al. (2023), Karim et al. (2022), and Pan et al. (2020). Firm size is unable to strengthen the effect of IT investment on return on assets due to the limitations in leveraging IT optimally at different scales. In larger companies, there is a more complex organizational structure and higher administrative costs, which often diminish the efficiency of IT investments. In this context, firm size does not directly enhance the effectiveness of IT in improving ROA, as operational needs differ and resources may be used in functions that do not directly impact asset performance (Stores et al., 2018; Szász et al., 2023). Additionally, the benefits of IT investment often require time, or what is known as a time lag, as noted by Campbell (2012) and Ravichandran et al. (2009).

5.4 Effect of IT Investment on ROE with Firm Size as a Moderating Variable

The hypothesis test, showing a t-statistic of 2,748751 and a p-value of 0,0069 for the interaction between IT investment and firm size, supports the rejection of H_0 and acceptance of H_a. This finding underscores that firm size (Z) plays a significant moderating role in the influence of IT investment on ROE in the banking sector in Indonesia.

Consistent with the research of Hasan et al. (2020), Karim et al. (2022), and Pan et al. (2020), this result shows that firm size, as a moderating factor, significantly bolsters the relationship with ROE. Contingency theory emphasizes the vital role of firm size in shaping the effectiveness of IT investment in improving performance.

5.5 Effect of IT Investment, Firm Size, and Interaction on ROA with Firm Size as a Moderating Variable

With a calculated F value of 2,159584 and a p-value of 0,096561, the F-test does not provide sufficient evidence to reject H_0. This reveals that, collectively, IT investment, firm size, and their interaction lack a significant impact on ROA in Indonesia's banking sector companies.

5.6 Effect of IT Investment, Firm Size, and Interaction on ROEwith Firm Size as a Moderating Variable

With a calculated F value of 13,43006 and a p-value of 0,000000, the F-test supports the rejection of H_0 and acceptance of H_1. This highlights the significant collective influence of IT investment, firm size, and their interaction on ROE within Indonesia's banking sector.

6. Conclusion, Implication, and Recommendation

These findings hold important applications for bank managers in planning technology investment strategies, particularly in the context of improving operational efficiency and competitiveness in an increasingly digital banking industry. By examining the intersection of IT investment and financial performance, this study enriches the academic disclosures on technological advancements in the banking sector.

For a more holistic understanding of the elements shaping financial performance, future studies should expand the observation period and introduce variables such as CAR (Capital Adequacy Ratio), NPL (Non-Performing Loans), and Operational Cost to Operating Income, along with other banking-related metrics.

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