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AN EMPIRICAL STUDY ON NATURAL DISASTER RISK AND ITS IMPACT ON RURAL BANK STABILITY AND THIRD-PARTY FUNDS IN INDONESIA

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Abstract: This study aims to analyze the impact of disaster risk on the stability and the ability of rural Indonesia to mobilize third-party funds. The data used in this research comprises information from 1,502 rural banks across 283 cities or regencies in 37 provinces. Observations of these rural banks were conducted over five years, from 2019 to 2023, yielding an unbalanced panel data with 7,226 observations. The methodology employed in this study is panel data analysis using a fixed effect model. The results indicate that disaster risk has a negative and significant effect on the stability of rural banks. In contrast, the ability of rural banks to mobilize third-party funds is not affected by disaster risk. A more in-depth analysis reveals that differences in rural banks' characteristics also influence the impact of disaster risk. Rural banks located on Java Island and those not owned by the government are more significantly impacted in terms of financial stability. Meanwhile, government-owned rural banks are more affected by their ability to mobilize third-party funds. These findings suggest that rural banks located on Java Island and those not government-owned should implement better risk mitigation measures, such as collaborating with larger financial institutions for asset management, to reduce the negative impact of disaster risk on economic stability.

Keywords: *Disaster risk, rural banks, bank stability, third-party fund*

Abstrak: *Penelitian ini bertujuan untuk menganalisis dampak risiko bencana terhadap stabilitas dan kemampuan perbankan pedesaan di Indonesia dalam memobilisasi dana pihak ketiga. Data yang digunakan dalam penelitian ini mencakup informasi dari 1.502 bank perkreditan rakyat (BPR) yang tersebar di 283 kota atau kabupaten di 37 provinsi. Pengamatan terhadap BPR ini dilakukan selama lima tahun, dari 2019 hingga 2023, menghasilkan data panel tidak seimbang dengan 7.226 observasi. Metodologi yang digunakan adalah analisis data panel dengan model efek tetap (fixed effect model). Hasil penelitian menunjukkan bahwa risiko bencana memiliki pengaruh negatif dan signifikan terhadap stabilitas BPR. Sebaliknya, kemampuan BPR dalam memobilisasi dana pihak ketiga tidak dipengaruhi oleh risiko bencana. Analisis lebih mendalam mengungkapkan bahwa perbedaan karakteristik BPR juga memengaruhi dampak risiko bencana. BPR yang berlokasi di Pulau Jawa dan yang bukan milik pemerintah lebih signifikan terdampak dalam hal stabilitas keuangan. Sementara itu, BPR yang dimiliki oleh pemerintah lebih terpengaruh dalam hal kemampuan memobilisasi dana pihak ketiga. Temuan ini menyarankan bahwa BPR yang berlokasi di Pulau Jawa dan yang bukan milik pemerintah perlu menerapkan langkah-langkah mitigasi risiko yang lebih baik, seperti bekerja sama dengan lembaga keuangan yang lebih besar untuk pengelolaan aset, guna mengurangi dampak negatif risiko bencana terhadap stabilitas ekonomi.*

Kata Kunci: *Risiko bencana alam, BPR, stabilitas bank, dana pihak ketiga*

INTRODUCTION

The increasing frequency of natural disasters occurring across various parts of the world is closely linked to the accelerating pace of climate change. Climate change is a negative outcome of human consumption and production behaviors (Gramlich et al., 2023). Major natural disasters significantly impact human life and economic conditions. According to the United Nations Office for Disaster Risk Reduction (UNDRR), natural disasters contribute up to 68.5% to the deterioration of global economic conditions (Do et al., 2023). Previous research has generally focused on the impact of natural disasters on the real sector, with primary discussions related to economic growth (Idroes et al., 2023) and other macroeconomic conditions.

Asia is one of the continents with a high potential for natural disasters (Nguyen et al., 2024). Natural disasters in Asia incur an economic cost of approximately USD 53 billion annually, with Indonesia, China, and the Philippines experiencing the most significant impacts (Idroes et al., 2023). Meanwhile, the impact of natural disasters on the financial sector is also gaining attention from banking regulators. This concern is reflected in a 2001 UNEP report stating that the increasing frequency of natural disasters can affect banks through business disruptions, potential bankruptcies due to loan repayment issues, increased debt, or large-scale withdrawals (Klomp, 2014). This issue has since been addressed by incorporating natural disasters into Basel meetings, where they were designated as operational risks for which banks must account. Natural disasters are considered operational risks because they can disrupt financial and operational systems, including payment and settlement systems.

Le et al. (2023) explain that climate change and environmental degradation are sources of structural change that affect economic activities and, consequently, the financial system. Climate and ecological damage typically trigger two types of risks. The first is physical risk, which relates to the financial impact of climate change, including more frequent extreme weather events and gradual changes in climate and environment, such as pollution, deterioration in water and soil quality, and loss of ecosystem and forest biodiversity. These negative impacts include damage to office buildings, disruption of economic activities, and supply chains, which may lead to a decline in the value of company assets. The second is transition risk, referring to the financial impact on companies due to adjustments needed to comply with new regulations aimed at large-scale climate change mitigation. This risk arises because companies must incur costs to align with the latest standards, ultimately affecting their profitability.

The research problems formulated in this study stem from exploring how natural disaster risk affects the stability of rural banks and their capacity to manage third-party funds. First, this study seeks to understand the direct impact of natural disaster risk on rural bank stability. Building on previous findings by Brei et al., (2019), which indicates that third-party fund levels are a crucial indicator of disaster risk impact; this research also examines how natural disasters influence third-party funds. Additionally, Wu & Lin (2024) and Alalmaee (2024) highlight the variability in disaster impacts based on location; thus, this study compares rural banks within Java-Bali and those outside to determine regional differences in the effects of natural disasters.

Furthermore, ownership influences bank stability (Diab et al., 2023), particularly given its interaction with significant events like political shifts. As a result, the study separately analyzes the impact of natural disaster risk on government-owned versus privately-owned rural banks. Consequently, the objectives of this study are to investigate the effects of natural disaster risk on bank stability and third-party funds, compare these impacts between rural banks on and off Java Island, and assess the differential effects on government versus private rural banks.

LITERATURE REVIEW

The impact of disaster risk on banks is multifaceted, with both direct and indirect channels influencing their stability and performance (Bos et al., 2022; Nguyen et al., 2024). Directly, natural disasters can damage banks' physical assets, disrupt operations, and destroy vital information on borrowers' creditworthiness. Indirectly, disasters affect banks by influencing the financial conditions of their borrowers and the broader economy, leading to challenges such as decreased deposits, increased credit risk, and reduced liquidity as cash inflows decline. The loss of collateral and repayment capacity among borrowers can delay or even result in defaulted loan payments, negatively impacting banks' asset quality and stability.

Nguyen et al. (2024) present theories on the impact of natural disasters on the financial sector. The Endogenous Growth Model explains through an increasing return-to-scale approach that natural disasters negatively affect companies. According to this theory, natural disasters damage companies' physical assets and human resources, with impacts occurring immediately or shortly after the disaster. These immediate impacts can evolve into short-term or long-term effects if business operations are disrupted. This theoretical approach is also applicable to financial institutions such as banks. Natural disasters impact borrowers and depositors, as borrowers' financial conditions may be compromised, making it difficult for them to repay loans and thereby increasing credit risk for banks. Simultaneously, depositors affected by disasters might withdraw their funds, posing a liquidity risk for banks. In addition to operational risks from damaged buildings or compromised information systems, these factors illustrate the broader risk landscape for banks during natural disasters.

However, empirical findings on the impact of disasters reveal some indirect effects that deviate from these immediate impacts (U-Din et al., 2023). Disasters allow banks to increase loan disbursements, as affected individuals are likely to seek loans, which could potentially raise interest income (U-Din et al., 2023). Banks can also benefit from inflows of funds from businesses or individuals receiving insurance claims to cover losses. Studies on the impact of natural disasters on banks generally focus on the implications for financial stability (Dunz et al., 2021; Fan & Gao, 2024; Wu & Lin, 2024; Ye et al., 2020). This focus reflects regulators' concerns that precise assessment is needed to deeply examine the vulnerabilities of the banking sector to disaster risks (Battiston et al., 2021). Natural disasters heighten the potential for loan defaults, threatening bank stability. On another front, disasters risk diminishing banks' capacity to gather third-party funds, as depositors may withdraw large sums to cover losses from natural disaster damages (Barth et al., 2024).

RESEARCH METHODOLOGY

The research design for this study is structured as follows. The first test examines the impact of disaster risk on rural banks' stability and third-party funds. Subsequently, the researcher divides the sample into rural banks in Java and those outside Java. The following regression analysis assesses the impact of disaster risk on the two dependent variables by categorizing them based on these locations. Further grouping is conducted by ownership type, dividing rural banks into government-owned and non-government-owned. Observations on rural banks stability and third-party funds will be analyzed according to these groupings.

The research data includes all rural banks with complete financial data on the Financial Services Authority (OJK) website, located at www.ojk.go.id. Disaster risk data is sourced from the disaster risk index available at inarisk.bnpb.go.id, which uses data from the ArcGIS server. Additional data sources include the Central Bureau of Statistics website (www.bps.go.id) for macroeconomic data. This study utilizes financial and macroeconomic data from the past five years, specifically from 2019 to 2023. Stability and third-party funds will be analyzed according to these groupings.

This study uses two dependent variables: bank stability and third-party funds. Bank stability is measured using the Z-score indicator (Alalmaee, 2024; Liu et al., 2024). The Z-score is calculated as follows:

$$Z_{it} = \frac{ROA_{it} + CAR_{it}}{\partial ROA_i}$$

In this calculation, ROA represents the return on assets ratio of rural banks *i* in year *t*, which is the ratio of net income to assets. Conversely, CAR denotes the capital adequacy ratio of rural banks *i* in year *t*. This study also uses the total third-party funds-to-assets ratio as a dependent variable (Brei et al., 2019). Total third-party funds represent the sum of all rural banks' savings and deposits

The primary independent variable in this study is the disaster risk for each region in Indonesia, measured using the Indonesian Disaster Risk Index (IRBI, Indeks Risiko Bencana Indonesia). IRBI is an index that reflects the actual disaster conditions in Indonesia (Khotimah, 2024) and is measured for each district and municipality. This study utilizes IRBI data at the district or municipal level.

This study includes control variables for other factors influencing the dependent variables. Bank size is one such factor, as it is believed to affect stability and third-party fund mobilization (Le et al., 2023). Accordingly, the log of assets is used as a proxy for size. Additional control variables specific to bank characteristics include Return on Assets (ROA) (Alalmaee, 2024) and the non-performing loan (NPL) ratio (Do et al., 2023). Furthermore, macroeconomic conditions are expected to play a role in rural banks' stability and funding capabilities (Battiston et al., 2021)Therefore, the study incorporates two macroeconomic control variables—Gross Domestic Product (GDP) growth and population size at the provincial level—to capture broader economic conditions that may impact rural banks' performance.

Although previous research has shown a positive impact of disasters on bank performance (Klomp, 2014), it is generally acknowledged that most studies observe a

negative effect of natural disasters on bank performance and stability (Erhemjamts et al., 2024). Based on this understanding, the hypotheses proposed in this study are as follows:

Hypothesis 1: Natural disaster risk has a negative impact on bank stability.

Hypothesis 2: Natural disaster risk has a negative impact on third-party funds.

Table 1 provides an overview of the proposed hypotheses, and the data sources used throughout this study. It aligns each variable with its corresponding hypothesis and identifies the data sources to analyze these relationships.

Table 1. Hypothesis and Data Source

Variable	Hypothesis	Data Source
Rural banks Stability	-	Calculated by author from www.ojk.go.id
Third-Party Funds (DPK)	-	www.ojk.go.id
Disaster Risk	Disaster risk negatively impacts stability and DPK	inarisk.bnpb.go.id
Size	Size positively impacts stability and DPK	www.ojk.go.id
NPL	NPL negatively impacts stability and DPK	www.ojk.go.id
ROA	ROA negatively impacts stability and DPK	www.ojk.go.id
GDP Growth	GDP growth positively impacts stability and DPK	www.bps.go.id
Population	Population positively impacts stability and DPK	www.bps.go.id

Source : Author's calculation using Stata 15

The study employs two empirical models as follows:

Empirical model 1:

$$Z_{it} = \beta_0 + \beta_1 RB_{ct} + \beta_2 SIZE_{it} + \beta_3 NPL_{it} + \beta_4 ROA_{it} + \beta_5 PDBGR_{pt} + \beta_6 POP_{pt} + \varepsilon$$

Empirical model 2:

$$DPK_{it} = \beta_0 + \beta_1 RB_{ct} + \beta_2 SIZE_{it} + \beta_3 NPL_{it} + \beta_4 ROA_{it} + \beta_5 PDBGR_{pt} + \beta_6 POP_{pt} + \varepsilon$$

Zit represents the stability level of the rural banks, measured by the Z-score proxy for each rural bank. This study uses the natural logarithm of the Z-score, which varies annually for each rural banks (Do et al., 2023). DPKit denotes the ratio of third-party funds to rural banks assets. It is calculated as the total third-party funds collected by the rural banks divided by its total assets, with differing values for each rural bank per year. RBct is disaster risk, measured by the Indonesian Disaster Risk Index (IRBI), which provides a standardized index for each district and municipality in Indonesia; rural banks in the same district share the same IRBI value. SIZEit represents the size of the rural banks, proxied by total assets, with this study using the logarithm of assets, and this value varies for each rural bank per year. NPLit denotes the rural banks' non-performing loan (NPL) rate, which varies by rural bank and year. ROAit is the return on assets ratio, calculated as net income to assets, and its values differ across rural banks and years. PDBGRpt refers to provincial GDP growth, consistent across rural banks within the same province but varies by province and year. POPpt is the population of each province, remaining constant across BPRs within the same province but differing across provinces. Finally, $\beta_0 - \beta_6$ represent constants and coefficients.

RESULT AND DISCUSSION

Descriptive Statistics

Table 2 presents descriptive statistics for all rural banks included in this study. The sample consists of 1,502 BPRs, located in 283 districts or municipalities across 37 provinces.

Table 2. Statistic Descriptive for All Observations

	Obs	Mean	Std. Dev.	Min	Max
Ln Z Score	7079	-3.795	0.732	-12.129	3.207
Third-party funds (%)	7226	63.7	20.1	3.15	92.4
Disaster risk	7226	124.697	30.58	48.13	217.62
Bank size	7226	17.621	1.262	8.626	23.071
ROA (%)	7218	1.938	4.968	-23.66	17.61
NPL (%)	7226	8.564	8.368	0	45.42
GDP Growth(%)	7226	3.1	3.5	-15.7	22.9
Population (thousand)	7226	26,717	20,242	701	50,406

Source : Author's calculation using Stata 15

The descriptive statistics reveal critical aspects of rural banks' performance and risk in Indonesia. The natural logarithm of the Z-Score (lnz) averages -3.795, indicating predominantly low to moderate financial stability, with a maximum of 3.207 showing higher stability in some banks. The third-party funds average 63.7%, suggesting a heavy reliance on external funds, raising potential liquidity risks if not properly managed. The Disaster Risk averages 124.697, reflecting that rural banks often operate in disaster-prone areas, posing operational stability challenges. Financially, the Return on Assets (ROA) averages 1.94%, indicating low profitability and notable variance. The Non-Performing Loan (NPL) ratio averages 8.56%, reaching a maximum of 45.42%, signaling major credit quality issues. An average GDP growth rate of 3.1% to positive economic growth, while vast differences in population, from 701,000 to over 50 million, suggest varied market potential across rural banks.

Table 3 presents descriptive statistics comparing rural banks in Java and those outside Java. The descriptive data reveals significant differences in financial stability and external risk conditions between Java and non-Java BPRs. Based on the natural log of the Z-Score (lnz), rural banks outside Java have an average score of -3.825, slightly lower than the -3.774 for Java BPRs, suggesting comparable financial stability across both regions.

Table 3. Descriptive Statistics of Rural Banks in Java and Outside Java

Outside Java

	N	Mean	Standard Deviation	min	max
Ln Z Score	2828	-3.825	0.787	-8.465	3.207
Third-party funds (%)	2890	66.7%	18.6%	3.1%	92.4%
Disaster risk	2890	129.078	26.939	48.13	217.62
Bank size	2890	17.505	1.273	8.626	23.071
ROA (%)	2890	1.72	5.223	-23.66	17.61
NPL (%)	2882	7.99	7.72	0	45.42
GDP Growth (%)	2890	2.81	4.41	-15.7	22.9
Population (thousand)	2890	6,008	3,220	701	15,389

Source : Author's calculation using Stata 15

Java

	N	Mean	Standard Deviation	Min	Max
Ln Z Score	4251	-3.774	0.692	-12.129	3.2
Third-party funds (%)	4336	61.7	20.6	3.1	92.4
Disaster risk	4336	121.778	32.460	49.5	215.2
Bank size	4336	17.699	1.249	13.065	21.925
ROA (%)	4336	2.086	4.786	-23.66	17.61
NPL (%)	4336	8.944	8.750	0	45.42
GDP Growth (%)	4336	3.4	3.1	-3.4	6.6
Population (thousand)	4336	40,519	14,127	3,668	50,406

Source : Author's calculation using Stata 15

The descriptive data underscores notable differences in financial stability and external risks between rural banks in Java and outside Java. The natural log of the Z-Score shows comparable financial stability, with non-Java banks averaging -3.825 and Java banks at -3.774. As the Disaster Risk indicates, external risks are also higher outside Java (129.078 vs. 121.778), signaling that non-Java banks operate in more disaster-prone areas, potentially challenging operational stability.

Profitability data reveals a slight advantage for Java rural banks, with an average ROA of 2.086% compared to 1.716% outside Java, though the higher variance outside Java highlights diverse profitability levels. Credit quality issues appear more pronounced in Java, where the NPL ratio averages 8.94% versus 7.994% outside Java. Java also benefits from a slightly higher GDP growth rate (3.4% vs. 2.8%), suggesting a steadier economic backdrop and a significantly larger population, averaging 40,519 thousand versus 6,008 thousand outside Java, presenting a broader market potential for Java BPRs.

Table 4 highlights the differences between government-owned and private-owned rural banks. Government-owned rural banks generally operate in areas with higher disaster risk (mean of 134.092) and show slightly higher profitability (ROA of 2.14%) compared to non-government rural banks (ROA of 1.91%). However, the NPL ratio is lower for government-owned rural banks (7.37%) than non-government rural banks (8.73%), indicating better credit quality management among government-owned rural banks.

Table 4. Descriptive Statistics of Rural Banks Private-Owned and Government-Owned

Private-Owned

	N	Mean	Standard Deviation	Min	Max
Ln Z Score	6239	-3.786	0.728	-12.129	3.205
Third-party funds (%)	6365	63.7	20.1	3.1	92.4
Disaster risk	6365	123.426	30.131	48.13	217.62
Bank size	6365	17.518	1.202	8.626	23.071
ROA (%)	6362	1.911	5.019	-23.66	17.61
NPL (%)	6365	8.726	8.453	0	45.42
GDP Growth (%)	6365	3.1	3.6	-15.7	22.9
Population (thousand)	6365	26210	20065	701	50406

Source : Author's calculation using Stata 15

Government-Owned

	N	Mean	Standard Deviation	Min	Max
Ln Z Score	840	-3.86	0.754	-7.429	3.207
Third-party funds (%)	861	.641	0.191	.03	.924
Disaster risk	861	134.092	32.214	49.5	215.2
Bank size	861	18.383	1.425	13.956	21.925
ROA (%)	856	2.14	4.566	-23.66	17.61
NPL (%)	861	7.366	7.608	0	45.42
GDP Growth (%)	861	.033	0.033	-.157	.229
Population (thousand)	861	30461	21143	701	50406

Source : Author's calculation using Stata 15

Multicollinearity Test

Table 5 presents the multicollinearity test results for all variables utilized in this study. The findings indicate no significant multicollinearity among the variables, ensuring the reliability of the regression analysis. Key observations include a moderate negative correlation between financial stability (lnz) and third-party fund dependency (depratio) at -0.487, as well as between lnz and asset size (logaset) at -0.334. This suggests that higher financial stability is associated with reduced reliance on third-party funds and larger asset sizes. Additionally, the correlation between depratio and disaster risk (irb) is weak (-0.043), indicating minimal impact of disaster risk on the ratio of third-party funds to assets. Profitability (roa) and non-performing loans (npl) exhibit a negative correlation of -0.276, implying that more profitable BPRs tend to have lower levels of non-performing loans. These results confirm the absence of multicollinearity, allowing for independent interpretation of the variables in the regression models.

Table 5. Multicollinearity Test

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(1) Ln Z Score	1.000							
(2) Third-party funds	-0.487	1.000						
(3) Disaster risk	0.000	-0.043	1.000					
(4) Bank size	-0.334	0.404	-0.118	1.000				
(5) ROA	0.290	-0.075	0.067	0.141	1.000			
(6) NPL	-0.007	-0.002	-0.072	-0.202	-0.276	1.000		
(7)GDP Growth	0.008	-0.035	-0.051	0.024	0.058	-0.033	1.000	
(8) Population	0.016	-0.097	-0.044	0.053	0.052	0.046	0.067	1.000

Source : Author's calculation using Stata 15

Regression Result

Table 6 presents the regression results based on the full dataset used in the study. The analysis applies a clustering approach using rural banks' names as the cluster identifier, ensuring that the standard errors account for heteroskedasticity and autocorrelation. As a result, the standard errors are robust, and the significance levels derived are no longer dependent on the assumptions of homoscedasticity or the absence of autocorrelation. This robust approach enhances the reliability and statistical significance of the regression outcomes.

Table 6. Baseline Result

	Ln Z score	Third Party Fund
Disaster Risk	-.003***	.000
	(.001)	(0)
Bank Size	-.147***	.019*
	(.05)	(.011)
ROA	.054***	-.004***
	(.006)	(.001)
NPL	-.001	.001***
	(.002)	(.000)
GDP gowth	-.748***	.138***
	(.203)	(.033)
Population	.000**	.000***
	(.000)	(.000)
_cons	-1.57*	.602***
	(.854)	(.206)
Observations	7079	7218
R-squared	.128	.044
F-stat	15.652	10.623

Standard errors are in parentheses
**** p<.01, ** p<.05, * p<.1*
Source : Author's calculation using Stata 15

The regression analysis using the fixed effect model provides insights into the influence of independent variables, including disaster risk, on rural banks' financial stability (Ln Z score) and funding structure (third-party fund). In the first model, where the Ln Z score is the dependent variable, disaster risk demonstrates a negative and significant effect on rural banks' financial stability, with a coefficient of -0.003 at a 1% significance level. This indicates that higher regional disaster risk is associated with declining rural banks' financial stability. Elevated disaster risk heightens operational uncertainty and impacts the rural banks' ability to maintain financial stability. These findings align with the first hypothesis, posing that disaster risk negatively affects rural banks' financial stability.

Natural disasters directly impact rural banks operations by damaging physical infrastructure, reducing borrowers' ability to repay loans, and disrupting economic activities in the affected areas. Such events can increase the rate of non-performing loans (NPL) and pressure profitability (ROA), ultimately lowering the Z-Score and overall financial stability. Rural banks operating in high-disaster-risk areas face additional challenges in mitigating these risks, necessitating cautious risk management strategies such as credit portfolio diversification or enhanced liquidity to absorb potential losses.

In the second model, where third-party funds are the dependent variable, disaster risk does not significantly affect the ratio of third-party funds to assets, with a near-zero coefficient. This finding suggests that while disaster risk influences rural banks' financial stability, its impact on the funding structure or dependence on third-party funds is relatively minor. Thus, these results are consistent with the second hypothesis, albeit with an insignificant relationship. Conversely, other variables, such as bank size and GDP growth, show more significant effects on third-party funds. This indicates that larger rural banks and those operating in regions with higher economic growth are more likely to rely on third-party funds.

Overall, the regression results underscore the importance of disaster risk as a key factor influencing rural banks' financial stability, particularly in disaster-prone regions. However, disaster risk has a limited impact on rural banks' funding structure, which is more heavily influenced by factors such as asset size and macroeconomic conditions in the operational regions.

Table 7 presents the regression results analyzing the effect of disaster risk on the financial stability of rural banks. The analysis is segmented by two criteria: rural banks located in Java versus outside Java and government-owned versus non-government-owned rural banks. This segmentation allows an in-depth understanding of how disaster risk impacts financial stability across different geographical and ownership contexts.

Table 7. Regression Results: Financial Stability Variables Grouped by Java and Non-Java Regions and Ownership (Government vs. Non-Government)

	(1)	**(2)**	**(3)**	**(4)**
	Ln Z Score	**Ln Z Score**	**Ln Z Score**	**Ln Z Score**
Disaster risk	-.002	-.004***	-.004***	-.001
	(.001)	(.001)	(.001)	(.001)
Bank size	-.096	-.234***	-.161***	.006
	(.082)	(.042)	(.054)	(.074)
ROA	.076***	.035***	.049***	.098***
	(.012)	(.006)	(.007)	(.025)
NPL	-.001	-.001	-.001	.011
	(.004)	(.002)	(.002)	(.008)
GDP Growth	-.747**	-1.064***	-.815***	-.093
	(.323)	(.179)	(.192)	(1.098)
Population	.000***	.000**	.000**	.000
	(0)	(0)	(0)	(0)
cons	-3.287***	-.259	-1.335	-3.033*
	(1.255)	(.844)	(.932)	(1.665)
Obs.,	2828	4251	6239	840
R-squared	.178	.107	.118	.242
F	9.414	14.713	13.109	2.945
Groups	Outside Java	Java	Private-owned	Government-owned

Standard errors are in parentheses
**** p<.01, ** p<.05, * p<.1*
Source : Author's calculation using Stata 15

The regression analysis using panel data highlights the impact of the independent variable, the disaster risk, on the financial stability of BPRs, segmented by region (Java and non-Java) and ownership (government-owned and non-government-owned rural banks). For rural banks in Java and non-government-owned rural banks, disaster risk exhibits a significant negative effect on financial stability, with a coefficient of -0.004 at a 1% significance level. This indicates that rural banks in regions with higher disaster risk experience a more significant decline in financial stability. Conversely, disaster risk is insignificant for rural banks outside Java and government-owned rural banks, suggesting that disaster risks in these areas may be better managed or have less pronounced impacts.

Beyond disaster risk, other independent variables also show varying effects on financial stability. Bank size consistently demonstrates a significant negative impact across all groups, with a more substantial effect in Java and non-government-owned rural banks. Larger rural banks appear to face more significant challenges in maintaining financial stability, potentially

due to higher operational complexity or more significant exposure to external risks. In contrast, profitability (ROA) significantly influences all groups, indicating that more financially profitable rural banks tend to have better stability and enhanced capacity to attract third-party funds.

GDP growth (PDBGR) also significantly affects rural banks' stability, particularly for non-Java and non-government-owned rural banks, with a significant negative coefficient. This suggests that high economic growth may paradoxically reduce financial stability in these areas, potentially due to increased expectations of rural banks' performance in growing regions, leading to heightened risks. The other argument is that rural banks in provinces with high GDP growth face higher competition from other institutions, such as commercial banks.

Table 8 displays the regression results with the ratio of third-party funds to assets as the dependent variable. The regression analysis is segmented based on rural banks in Java versus non-Java regions and by ownership type, distinguishing between government-owned and non-government-owned rural banks.

Table 8. Regression Results: Third-Party Fund Ratio Variables Grouped by Java and Non-Java Regions and Ownership (Government vs. Non-Government)

	(1)	**(2)**	**(3)**	**(4)**
	Third-party fund	**Third-party fund**	**Third-party fund**	**Third-party fund**
Disaster risk	.000	.000	.000*	-.000*
	(0)	(0)	(0)	(0)
Bank size	.013	.027*	.024**	-.043
	(.016)	(.016)	(.012)	(.036)
ROA	-.004***	-.004***	-.004***	-.003
	(.001)	(.001)	(.001)	(.002)
NPL	.001**	.001**	.001***	.001
	(.001)	(0)	(0)	(.001)
GDP Growth	.191***	.098***	.158***	-.056
	(.05)	(.036)	(.035)	(.076)
Population	0**	0***	0***	0
	(0)	(0)	(0)	(0)
Cons	.636**	.542*	.536**	1.47**
	(.285)	(.291)	(.22)	(.659)
Obs	2882	4336	6362	856
R-squared	.046	.048	.045	.094
F	5.036	7.011	10.657	2.175
Groups	Non-Java	Java	Private-owned	Government-owned

Standard errors are in parentheses

**** p<.01, ** p<.05, * p<.1*

Source : Author's calculation using Stata 15

The regression analysis using the fixed effect model highlights the impact of Disaster Risk on the ratio of third-party funds to assets, segmented by region (Java vs. non-Java) and ownership status (government-owned vs. non-government-owned). These results offer insights into how disaster risk influences the funding structure of rural banks in different contexts.

For rural banks outside Java, the effect of disaster risk on third-party funds is not significant, with a coefficient of 0.000. This suggests that disaster risks in these regions do not significantly influence rural banks' reliance on third-party funds. This finding might

indicate that rural banks outside Java have better risk mitigation strategies or have adapted more effectively to disaster risks, thus avoiding significant third-party fund withdrawals during disasters. Similarly, in Java, the impact of disaster risk on third-party funds is also insignificant (0.000), suggesting that disaster risk does not trigger substantial fund withdrawals from rural banks in these regions. These results contradict the second hypothesis, which expected a negative impact of disaster risk on third-party funds.

However, for non-government-owned rural banks, disaster risk has a significant positive effect on third-party funds, with a coefficient of 0.003 at a 10% significance level. This indicates that non-government rural banks operating in high-risk areas do not experience a decline in third-party funds during disasters. Contrary to the expectations outlined in the second hypothesis, these institutions appear more prepared to handle disaster-related challenges, particularly in maintaining their ability to attract third-party funds.

Conversely, for government-owned rural banks, the impact of disaster risk on third-party funds is negative and significant, with a coefficient of -0.000 at a 10% significance level. This implies that government-owned rural banks tend to experience a decline in third-party funds during increased disaster risks. This may be due to these institutions' inability to reassure customers to retain their deposits during disasters. The contrasting outcomes for non-government and government-owned rural banks underscore the crucial role of ownership status in shaping the strategies rural banks employ to respond to external risks like natural disasters.

Beyond disaster risk, other independent variables also significantly influence third-party funds across various rural bank groups. Bank size significantly positively affects third-party funds in Java and non-government-owned rural banks, with coefficients of 0.027 and 0.024, respectively. Larger rural banks in these categories likely rely more on third-party funds due to broader operations and higher funding needs. However, bank size only significantly impacts rural banks outside Java or government-owned rural banks, suggesting that bank size plays a less critical role in influencing funding structures in these groups.

Profitability (ROA) shows a significant negative relationship with third-party funds across all groups, indicating that more profitable rural banks tend to rely less on third-party funds. This is logical, as higher profitability allows these institutions to use internal resources to finance operations. Non-performing loans (NPL) have a significant and positive impact on third-party funds, especially for non-government-owned and non-Java BPRs, with a coefficient of 0.001. This suggests that higher levels of problematic loans increase dependence on third-party funds, possibly to cover potential credit losses.

GDP growth significantly negatively influences third-party funds across all groups, particularly for non-government-owned BPRs. This indicates that higher economic growth reduces dependence on third-party funds. It is likely because improved economic conditions lead customers to deposit their funds in other financial institutions, making rural banks' savings products less attractive.

The findings of this study can be contextualized within the Endogenous Growth Model, which emphasizes the role of internal factors—such as investment in human capital, innovation, and institutional structures—in influencing economic and organizational growth (Beck et al., 2005; Klomp, 2014). According to this model, disruptions like natural disasters can hinder growth by affecting key inputs such as infrastructure, capital, and operational

continuity. However, the response to these disruptions, as seen in the differentiated impact on rural banks, aligns with the model's assertion that growth and stability depend on how organizations adapt and manage internal and external challenges.

CONCLUSION

The study examined the impact of disaster risk on the financial stability of rural banks (BPR) in Indonesia and their capacity to mobilize third-party funds, using data from 1,502 rural banks across 283 cities or regencies over five years (2019–2023). The findings reveal that disaster risk significantly undermines the financial stability of rural banks, as reflected in lower Z-scores. Banks in disaster-prone areas, especially on Java Island, face more significant challenges in maintaining stability. Non-government-owned rural banks are particularly vulnerable, suggesting that ownership is critical in resilience to disaster-related risks.

In contrast, disaster risk has a limited overall impact on rural banks' ability to mobilize third-party funds. However, government-owned rural banks are slightly more affected, showing a negative relationship between disaster risk and third-party fund mobilization. This difference highlights the need for more robust strategies among government-owned banks to manage depositor confidence during disasters.

Geographical and ownership differences further underscore the complexity of disaster risk impacts. Rural banks outside Java appear more resilient to disaster risks, maintaining better stability than their Java-based counterparts. Government-owned banks exhibit slightly better credit quality management but face greater challenges in retaining third-party funds during disaster periods.

Factors like bank size and macroeconomic conditions significantly influence rural banks' financial outcomes. Larger banks often struggle with maintaining stability due to their operational complexity, while GDP growth positively affects third-party fund mobilization. Profitability (ROA) consistently emerges as a key factor supporting financial stability across all rural banks.

These findings emphasize the necessity for tailored risk mitigation strategies for rural banks, considering their specific location and ownership structure. Collaborative partnerships with larger financial institutions and robust risk management frameworks are recommended to help rural banks, particularly those in high-risk areas, better navigate the challenges posed by natural disasters.

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