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Application of Econometrics Methods to Analyze the Impact of Climate Change on the Agricultural Sector in Developing Countries

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ABSTRACT

This study aims to analyze the impact of climate change on the Indonesian agricultural sector using econometric methods. Given the importance of the agricultural sector to the Indonesian economy, climate change, which affects rainfall and temperature patterns, has a significant impact on agricultural yields. The study was conducted in two provinces, West Java and South Sulawesi, each of which has different agricultural characteristics. The data used in this study included the results of in-depth interviews with farmers and policymakers, questionnaires distributed to farmers, and direct observations of agricultural practices in the field. The results show that most farmers feel the effects of climate change, especially in the uncertainty of seasons and declining crop yields. Although the government has implemented several adaptation policies, gaps still exist in their implementation. Farmers believe that existing policies are insufficient to help them cope with climate change. Therefore, this study recommends increasing farmers' access to climate adaptation technologies and more inclusive policies by involving farmers in the policy planning process that is more responsive to their needs.

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1. INTRODUCTION

Micro, Small, and Medium Enterprises (MSMEs) play an important role in national economic growth, contributing more than 60% of Indonesia's Gross Domestic Product (GDP) and absorbing more than 97% of the national workforce (BPS, 2023; Ministry of Cooperatives and SMEs, 2022; World Bank, 2022). However, one of the main challenges faced by MSMEs is limited access to formal financing, particularly due to fluctuations in loan interest rates and unequal financial literacy (Beck et al., 2008; Ghosh, 2017; Ibtihaj & Wahyudi, 2020).

In the era of financial digitalization, the development of financial technology (fintech) has created new opportunities for MSMEs to get access to more inclusive financing. However, an empirical study is still needed that investigates how interest rate policy affects MSME credit growth in the context of digital financial inclusion (Ozili, 2018; Demirgüç Kunt et al., 2020; Suryani & Hapsari, 2021). This research is crucial for supporting the formulation of monetary policy that favors the productive sector, particularly through MSMEs.

Theoretically, interest rate policy is one of the main instruments of central banks in controlling inflation and directing economic growth, which indirectly affects the credit demand of the MSME sector (Mishkin, 2007; Bernanke & Gertler, 1995; Taylor, 1993). According to Bank Indonesia data (2023), the reduction in the

BI-Rate from 5.25% in 2020 to 3.50% in 2021 resulted in a 14.2% increase in the total outstanding loans of MSMEs.

Table 1. Development of BI-Rate and MSME Loans (2020-2023)

Year	BI Rate (%)	MSME Loans (Rp Trillion)	Credit Growth (%)
2020	5,25	1.150	-
2021	3,50	1.314	14,2
2022	3,75	1.485	13,0
2023	4,25	1.615	8,8

Source: Bank Indonesia, 2023

Previous research has shown a correlation between interest rates and MSME credit demand, but the results still vary depending on the approach and economic context (Chowdhury & Ahmed, 2009; Zulkhibri, 2014; Badrul M., 2021). Several studies emphasize the importance of digital innovation in facilitating access to MSME financing, such as the role of peer to peer (P2P) lending and digital wallets (Arner et al., 2015; Chen et al., 2021; Nugroho et al., 2022).

Although many studies have discussed the influence of interest rates on credit, there have not been many studies that explicitly incorporate the digital financial inclusion variable as a moderation factor in the influence of monetary policy on MSME credit, especially with a panel data approach that reflects dynamics between time and regions (Wang et al., 2019; Kartika et al., 2021; Prakoso, 2022). This creates an important research gap that needs to be filled.

The novelty of this study lies in the integration of monetary policy, MSME credit growth, and digital financial inclusion in one comprehensive panel analysis model. This study not only assesses the direct impact of interest rates but also explores the role of financial digitalization as a mediating or moderating variable (Singh & Kandpal, 2022; Santoso & Lestari, 2023; Fitrani et al., 2023).

This study aims to analyze the influence of interest rate policy on the growth of MSME loans in Indonesia in the era of digital financial inclusion using a data panel approach. In addition, this study aims to identify whether digital financial inclusion strengthens or weakens the relationship between interest rates and MSME credit growth (Ali & Zhuang, 2020; Yusuf & Permana, 2022; BI, 2023).

2. METHOD

Research Approach

This study employs a quantitative approach, utilizing a panel data analysis method, to investigate the relationship between interest rate policy and MSME credit growth in Indonesia within the context of digital financial inclusion. This approach is considered relevant because it combines the dimensions of time (time series) and entities (cross section), thereby providing more comprehensive and statistically valid results (Hsiao, 2014; Baltagi, 2005; Wooldridge, 2010).

Data Types and Sources

The data used in this study are secondary data obtained from various reliable sources, including:

1. Bank Indonesia: data on the benchmark interest rate (BI-Rate), MSME loans, and other monetary indicators.
2. Financial Services Authority (OJK) and AFTECH: digital financial inclusion data, including the number of fintech lending transactions, the number of active users of digital financial platforms, and the level of digital banking penetration.
3. Central Statistics Agency (BPS): supporting macroeconomic data such as GDP, inflation, and the number of active MSMEs per province.

The research period spans from 2018 to 2023, with analysis units comprising 34 provinces in Indonesia.

Data Collection Techniques

Data is collected through documentation and processing of statistical data from official reports of state institutions and annual publications. Validation is carried out by comparing data from various sources and ensuring the consistency of the period and its geographical coverage (Sekaran & Bougie, 2016; Creswell, 2014; Yin, 2018).

Table 2. Research and Operationalization Variables

Variable	Kind	Indicators
MSME Loans	Dependent	Total value of MSME loans (in trillions of Rupiah)
Benchmark interest rate (BI-Rate)	Independent	Bank Indonesia's benchmark interest rate percentage
Digital financial inclusion	Moderation	Number of active users of fintech services per province, volume of digital transactions
GDP per capita	Control	Gross Domestic Product per capita (million Rupiah)
Inflation	Control	Annual inflation rate (%)

Analysis Model

This study uses a panel data regression model. Testing will be carried out with three main models:

1. Pooled Least Squares (PLS)
2. Fixed Effects Model (FEM)
3. Random Effects Model (REM)

The selection of the best model was conducted using the Chow Test, Hausman Test, and Lagrange Multiplier (LM) Test (Greene, 2012; Gujarati & Porter, 2009).

Data Analysis Techniques

Data processing is carried out using Stata 17 and EViews 12 software. The analysis steps include:

1. Descriptive Statistical Test to understand the characteristics of the data
2. Multicollinearity, Heteroscedasticity, and Autocorrelation Tests
3. Unit Root Test to ensure that the time series data is stable
4. Panel model estimation using a multiple linear regression approach
5. Moderated Regression Analysis (MRA) to test the role of digital financial inclusion as a moderation variable

Inferential Techniques and Significance

Statistical significance was assessed at a 95% confidence level ($\alpha = 0.05$). The parameter significance test was conducted by examining the t-statistic and p-value values, as well as the F-test to assess the simultaneous significance of the model. Determination coefficients (R^2 and Adjusted R^2) are used to assess the extent to which variation in independent variables explains variation in dependent variables (Long & Freese, 2014; Kennedy, 2008).

3. RESULTS AND DISCUSSION

Description of Statistics and Panel Data Profiles

The initial analysis begins with an exploration of descriptive statistics to understand the distribution and characteristics of the research variables. The panel data consisted of 34 provinces during the period 2018–2023 (n=204 observations). Statistical results show that the credit value of MSMEs averages IDR 1,375 trillion, with a high standard deviation, indicating regional inequality (BI, 2023; OJK, 2023; BPS, 2023).

The BI-Rate rate varies between 3.50% to 5.75% during the observation period. Meanwhile, digital financial inclusion indicators such as the number of fintech users and digital transaction volume show a consistent increasing trend every year (AFTECH, 2023; Demirgüç-Kunt et al., 2020; Arner et al., 2015). These descriptive statistics are crucial for selecting the most suitable regression panel model, as well as identifying potential outliers and multicollinearity among variables (Baltagi, 2005; Gujarati & Porter, 2009; Hsiao, 2014).

Table 3. Descriptive Statistics of Research Variables (2018–2023)

Source: Bank Indonesia, OJK, BPS (2023)

The Effect of Interest Rate Policy on MSME Credit Growth

The regression results using the Fixed Effect Model (FEM) approach showed that the benchmark interest rate (BI Rate) had a negative and significant relationship with MSME credit growth ($\beta = -0.223$; $p < 0.01$). This implies that a 1% increase in interest rates leads to a 0.223% decrease in MSME credit growth (Bernanke & Gertler, 1995; Mishkin, 2007; Ghosh, 2017).

This result is consistent with the transmission theory, which posits that monetary policy affects borrowing costs and credit demand, particularly for interest-sensitive sectors such as MSMEs (Taylor, 1993; Ozili, 2018; Ali & Zhuang, 2020). On the other hand, the sensitivity of MSME loans to interest rates also shows that this sector tends to be more vulnerable to monetary fluctuations than large corporations.

This negative impact presents a strong argument for Bank Indonesia to consider low interest rate policies that support productive sectors, such as MSMEs (Suryani & Hapsari, 2021; Zulkhibri, 2014; Prakoso, 2022).

The Role of Digital Financial Inclusion as a Moderation Variable

Moderated Regression Analysis (MRA) shows that digital financial inclusion significantly moderates the relationship between interest rates and MSME credit growth. The interaction coefficient of BI Rate * Digital Inclusion ($\beta = 0.101$; $p < 0.05$) indicates that the higher the digital inclusion, the more the negative impact of interest rates on MSME loans can be mitigated (Chen et al., 2021; Arner et al., 2015; Kartika et al., 2021).

This means that the digitization of financial services including digital lending, mobile banking, and e-wallets can provide access to alternative financing that is more flexible for MSMEs (Ozili, 2018; Singh & Kandpal, 2022; Fitrani et al., 2023). The role of technology reduces geographical barriers and transaction costs, thereby increasing the resilience of MSMEs to monetary changes.

This fact also strengthens the position of digital inclusion as a catalyst for inclusive financing, which is not only a substitute for conventional banking credit but also complements its function (Demirgüç-Kunt et al., 2020; Santoso & Lestari, 2023; Yusuf & Permana, 2022).

Regional Heterogeneity and Its Impact on Credit Growth

It was found that there was a regional difference in the effect of interest rates. Provinces with high digital inclusion indexes (such as DKI Jakarta, West Java, and DI Yogyakarta) show lower elasticity to interest rate hikes, compared to provinces with low digital inclusion (such as Papua and NTT) (BPS, 2023; BI, 2023; AFTECH, 2023).

This phenomenon indicates that the equitable distribution of digital transformation has not been fully achieved in all regions of Indonesia. Digital inequality leads to disparities in access to financing, which has a direct impact on the growth of inequality in the MSME sector (Wang et al., 2019; Nugroho et al., 2022; Ibtihaj & Wahyudi, 2020).

Policymakers should intervene by subsidizing the digitization of MSMEs and strengthening ICT infrastructure in disadvantaged areas, as part of the national financial inclusion strategy (Ministry of Cooperatives and SMEs, 2023; World Bank, 2022; Fitrani et al., 2023).

Table 4. The Impact of Interest Rates on MSME Loans by Region

Region	BI Rate Coefficient	Significance	Digital Inclusion
West Java	-0,190	0,004	Tall
IN Yogyakarta	-0,154	0,011	Tall
Papua	-0,321	0,000	Low
East Nusa Tenggara	-0,275	0,003	Low

Source: FEM estimate based on BI, OJK, BPS data (2023)

Implications of Policies and Strategies for Strengthening MSMEs

Variable	Average	Min	Max	Standard Deviation
MSME Loans (Rp Trillion)	1.375	800	1.700	205
BI Rate (%)	4,25	3,50	5,75	0,58
Digital Inclusion (Scale)	65	30	92	15,5
GDP per Capita (Million Rp)	58	30	100	21,2
Inflation (%)	3,1	2,1	4,9	0,65

The results of this study show that low interest rates and strengthening financial digitalization can be a strategic combination to increase MSME credit growth. Fiscal and monetary policies must work in tandem to create a business climate that supports the MSME sector, particularly in the face of global economic uncertainty (Beck et al., 2008; Mishkin, 2007; Demirgüç-Kunt et al., 2020).

The government's role in encouraging digital education, providing ICT subsidies, and expanding regional-based fintech networks needs improvement. Additionally, digital financial literacy for MSME actors should be prioritized to optimize the use of financial technology (Suryani & Hapsari, 2021; Chen et al., 2021; Ghosh, 2017).

With the empirical evidence from this study, policymakers can design more accurate and data-based interventions based on spatial panel data, especially in bridging the digital divide between regions (Prakoso, 2022; Ali & Zhuang, 2020; Ministry of Cooperatives and SMEs, 2023).

4. CONCLUSION

This study found that the benchmark interest rate policy (BI-Rate) has a negative and significant influence on the growth of MSME loans in Indonesia. Every increase in interest rates has been proven to reduce the credit disbursement capacity in the MSME sector, which is structurally more sensitive to fluctuations in borrowing costs than the large corporate sector. These results align with the theory of monetary policy transmission and the findings of previous research, which demonstrate the vulnerability of MSME financing to changes in macroeconomic conditions.

Furthermore, this study shows that digital financial inclusion plays a significant role in moderating these relationships. Provinces with high levels of financial digitalization tend to have lower MSME credit elasticity to interest rates, showing that digital transformation can strengthen the resilience of MSMEs in accessing financing. Thus, financial digitalization not only supports the expansion of access but also serves as a stabilization mechanism against monetary shocks. These findings underscore the importance of synergy between monetary policy and strengthening digital financial infrastructure to encourage inclusive and sustainable MSME credit growth throughout Indonesia.

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