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Original Article

Does Education Reduce Crime? Reexamining the Socioeconomic Determinants of Crime in Aceh, Indonesia

Indra Ismawan [a], Teuku Zulham [a] and Suriani Suriani [a,*]

[a] Department of Economics, Faculty of Economics and Business, Universitas Syiah Kuala, 23111 Syiah Kuala, Banda Aceh, Indonesia.
* Correspondence: suriani@usk.ac.id (S.S.)

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Abstract: Crime remains a critical socioeconomic issue in developing regions, where structural inequalities, labor market constraints, and institutional factors interact to shape criminal behavior. In Indonesia, particularly in Aceh Province, crime rates remain relatively high despite ongoing efforts to reduce poverty and expand education. Existing literature often assumes that poverty increases crime and that education reduces it; however, empirical findings remain inconsistent and context dependent. Moreover, prior studies tend to analyze these determinants separately and rely on static models, limiting their ability to capture dynamic interactions and endogeneity. This study addresses these gaps by examining the dynamic effects of poverty and education on crime, with unemployment included as a control variable. The study employs quarterly panel data from 23 districts and cities in Aceh Province over the period 2019 to 2023. It applies a dynamic panel estimation using the First-Difference Generalized Method of Moments. The results indicate that poverty has a negative and significant effect on crime, suggesting that economic deprivation alone does not directly increase criminal activity in this context. In contrast, education shows a positive, significant relationship with crime, reflecting a mismatch between educational attainment and labor-market opportunities. Unemployment has a strong positive effect on crime, indicating that labor market conditions play a dominant role in shaping criminal behavior. The findings highlight that crime dynamics in Aceh are driven more by structural and institutional factors than by poverty alone. This study concludes that effective crime reduction requires integrated policies that align education with employment opportunities and strengthen labor-market absorption, while maintaining social cohesion.

Keywords: Crime rate; Poverty; Education; Unemployment; Dynamic panel data; Generalized Method of Moments (GMM) Approach

1. Introduction

Crime refers to any act that violates legal norms and is subject to formal sanctions. From a sociological and criminological perspective, crime reflects behavior that harms individuals and society, generates victims, and triggers social responses (Rusnani, 2015). Crime is not only a legal issue but also a social phenomenon shaped by structural, economic, and institutional conditions. In developing countries such as Indonesia, crime has become increasingly

complex and multidimensional, affecting various segments of society and reflecting broader socioeconomic inequalities (Rahmi & Adry, 2018; Putra et al., 2021). A large body of literature identifies poverty as a central determinant of criminal behavior. Empirical studies suggest that individuals facing economic deprivation are more likely to engage in crime due to unmet basic needs and limited access to resources (Prayetno, 2013; Dulkiah & Nurjanah, 2018; Rahmalia et al., 2019; Putra et al., 2021). This argument aligns with economic crime theory, which posits that individuals weigh the expected benefits and costs of illegal activities under conditions of economic pressure (Becker, 1968). However, crime is not homogeneous.

While poverty-related crimes are often associated with lower-income groups, white-collar crimes such as corruption and fraud are typically committed by individuals with economic and political power, producing broader systemic harm (Kamasa, 2014). This distinction indicates that crime is influenced by both economic necessity and opportunity structures. Crime also poses a direct threat to human security, which constitutes a fundamental dimension of welfare and development. Governments face increasing pressure to design policies that reduce crime through both preventive and corrective measures (Levitt, 2004; Putra et al., 2021). In Indonesia, official statistics indicate persistent regional disparities in crime rates, reflecting uneven socioeconomic development (Badan Pusat Statistik, 2023). Aceh Province presents a particularly relevant case. Recent data show that crime levels remain relatively high, with more than 15,000 reported cases in 2023 and significant variation across districts (see Figure 1). Banda Aceh records the highest number of cases, while smaller regions such as Sabang report substantially lower levels. These statistics, derived from police reports, capture only reported incidents and therefore provide a macro-level approximation of crime dynamics (Badan Pusat Statistik, 2023). The persistence of crime in Aceh raises critical questions about the effectiveness of existing socioeconomic policies.

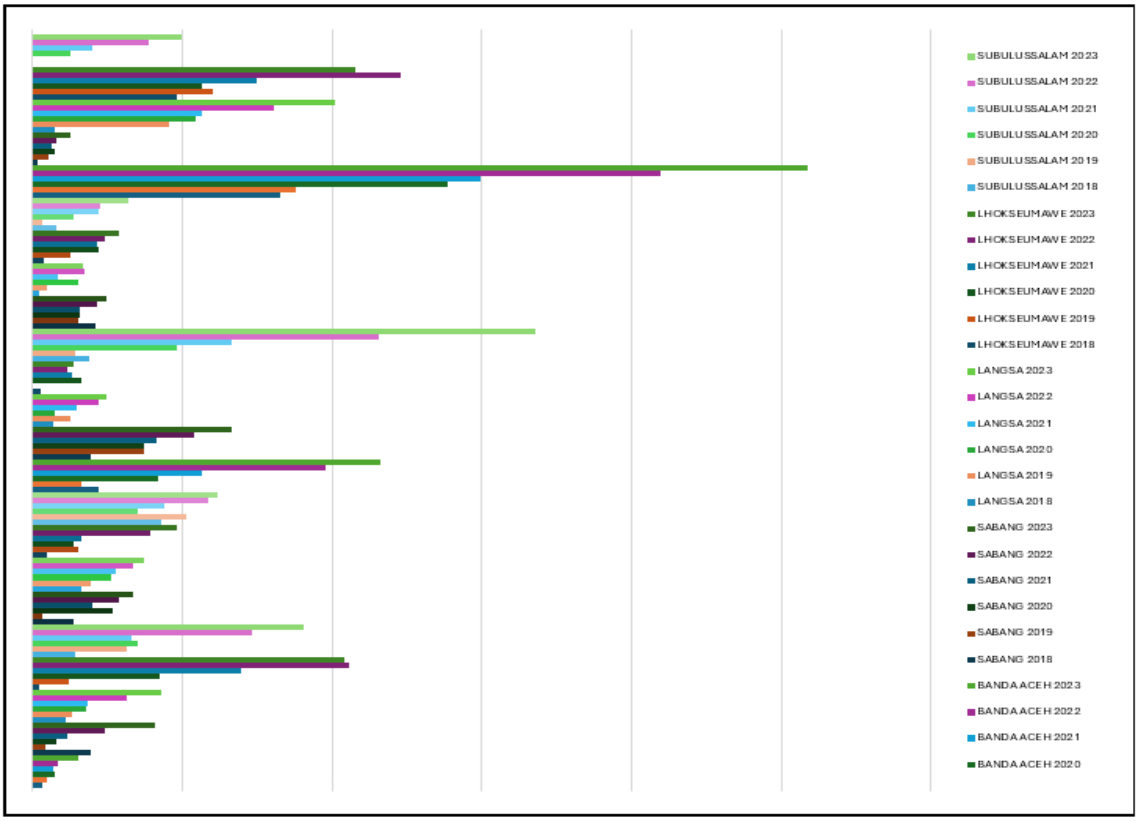

Figure 1. Number of Reported Crimes in Aceh Province from 2018 to 2023

From a theoretical perspective, crime is closely linked to human needs and welfare conditions. According to Maslow's hierarchy, safety is a fundamental requirement following physiological needs, and exposure to crime undermines this sense of security (Bari & Hidayat, 2022). In contexts where poverty remains high, individuals face difficulties in meeting basic needs such as food, housing, and education, which may increase the risk of deviant behavior (Dong et al., 2020). Empirical evidence supports the positive relationship between poverty and crime, particularly in environments characterized by limited economic opportunities and weak institutional support (Sari & Azhar, 2019; Mocan & Rees, 2005). However, the poverty–crime relationship is not universally consistent. Some studies find that social, cultural, and institutional factors can moderate this relationship, reducing the direct impact of poverty on criminal

activity (Kleck et al., 2001; Levitt, 2004). This suggests that economic variables alone are insufficient to explain crime dynamics, and a broader analytical framework is required.

Education represents another critical determinant of crime. Human capital theory argues that education enhances skills, increases legal income opportunities, and reduces incentives to engage in criminal behavior (Becker, 1968; Machin et al., 2011; Moretti, 2004). Empirical studies generally support the crime-reducing effect of education, particularly when it improves employability and income prospects (Mustofa & Suryadarma, 2018). However, recent evidence highlights a more complex relationship. When educational expansion is not matched by labor market absorption, it may generate frustration and unmet expectations, potentially increasing criminal tendencies among educated individuals (Fella & Gallipoli, 2014; Machin & Meghir, 2004).

Unemployment further complicates this relationship. It reflects the economy's failure to absorb available labor and is associated with reduced income, social exclusion, and psychological stress (Mervita et al., 2022). According to macroeconomic theory, unemployment arises when labor supply exceeds demand, often due to structural inefficiencies and slow economic growth (Sukirno, 2000; Nanga, 2001). Empirical studies consistently find a positive relationship between unemployment and crime, as individuals facing income loss may turn to illegal activities as alternative survival strategies (Raphael & Winter-Ebmer, 2001; Pohan, 2020). In Aceh, unemployment remains relatively high, averaging nearly 6 percent across districts, with significant variation between regions (see Figure 2). Urban areas such as Lhokseumawe exhibit higher unemployment rates, reflecting structural labor market imbalances. These conditions create socioeconomic vulnerabilities that may contribute to crime (Aditama, 2021).

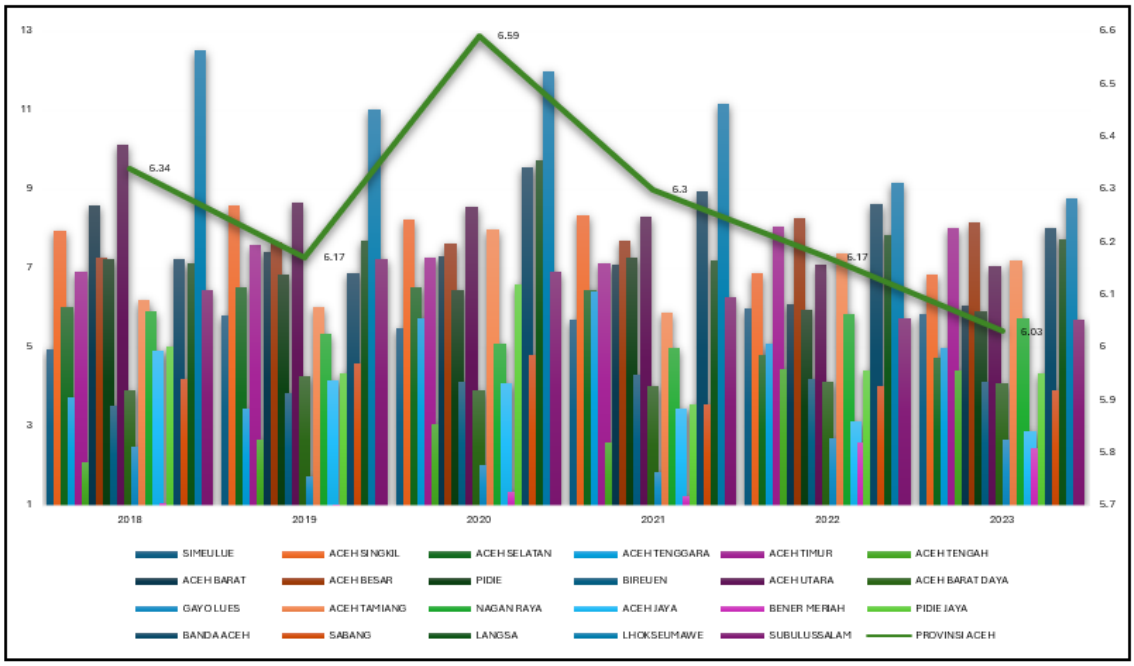

Figure 2. Open Unemployment Rate in Districts/Cities of Aceh Province, 2018–2023

Source: Aceh Central Statistics Agency (2024)

Despite extensive literature on crime determinants, several critical gaps remain. First, existing studies often assume a linear, positive relationship between poverty and crime, yet empirical findings across regions are inconsistent, suggesting that contextual factors, such as culture and social institutions, also play a role (Dong et al., 2020; Kleck et al., 2001). Second, the relationship between education and crime remains theoretically ambiguous. While human capital theory predicts a negative effect, recent studies reveal that education may increase crime when labor market opportunities are limited (Machin et al., 2011; Fella & Gallipoli, 2014). This contradiction has not been sufficiently explored in the Indonesian context. Third, many studies analyze poverty, education, and unemployment in isolation, without integrating them into a dynamic framework that captures their interdependence over time (Baltagi, 2021; Arellano & Bond, 1991). Fourth, empirical research on crime in Indonesia, particularly in Aceh, remains limited in methodological rigor, often relying on static models that fail to address endogeneity and temporal dynamics. Given these gaps, the present study aims to analyze the dynamic relationship among poverty, education, and crime in Aceh Province, with unemployment included as a control variable.

2. Literature Review

2.1. Underlying Theory

Economic and sociological theories provide the primary basis for explaining criminal behavior. The economic theory of crime developed by Becker (1968) treats crime as a rational decision in which individuals compare expected benefits with potential costs. This framework predicts that adverse economic conditions, such as low income or unemployment, increase the likelihood of criminal activity. Empirical extensions confirm that incentives and constraints shape criminal behavior, although the magnitude of effects varies across contexts (Machin & Meghir, 2004; Mocan & Rees, 2005). However, purely economic explanations are insufficient. Sociological perspectives emphasize structural inequality and social strain. Individuals who fail to achieve socially accepted goals due to limited resources may experience pressure that leads to deviant behavior (Prayetno, 2013; Sari & Azhar, 2019). This perspective suggests that crime emerges from the interaction between economic deprivation and social context. Therefore, crime should be analyzed as a multidimensional phenomenon rather than a purely economic outcome.

2.2. Poverty and Crime

A substantial body of literature identifies poverty as a key determinant of crime. Studies in Indonesia consistently show that higher poverty levels increase criminal activity due to unmet basic needs and restricted access to opportunities (Dulkiah & Nurjanah, 2018; Rahmalia et al., 2019; Putra et al., 2021). International evidence also supports this relationship, particularly in developing economies with high economic vulnerability (Dong et al., 2020). Despite this consensus, empirical findings remain inconsistent. Some studies find that poverty does not significantly affect crime once institutional and social factors are taken into account (Levitt, 2004). Others suggest that local cultural norms and informal social control can mitigate the criminogenic effects of poverty (Kleck et al., 2001). This divergence indicates that poverty alone cannot fully explain crime patterns. In the Indonesian context, the relationship between poverty and crime is complicated by regional heterogeneity. Provinces differ in terms of social cohesion, religious values, and institutional strength. These factors may weaken or even reverse the expected positive relationship between poverty and crime. Existing studies rarely incorporate these contextual dimensions, resulting in incomplete explanations of crime dynamics.

2.3. Education and Crime

Education is widely regarded as a mechanism for reducing crime through human capital accumulation. According to human capital theory, education increases productivity, improves employment prospects, and raises legal income, thereby reducing incentives to engage in criminal behavior (Becker, 1968; Moretti, 2004). Empirical studies confirm that higher educational attainment generally correlates with lower crime rates (Machin et al., 2011; Mustofa & Suryadarma, 2018). However, recent literature highlights a more complex relationship. When education expansion is not accompanied by adequate labor-market absorption, it may lead to dissatisfaction among educated individuals. This condition can increase the likelihood of criminal behavior due to unmet expectations (Fella & Gallipoli, 2014). Machin and Meghir (2004) further argue that education influences crime indirectly, through labor-market outcomes rather than directly through knowledge or values. In developing regions, including Indonesia, the quality of education and its relevance to labor market needs remain critical issues. Increasing access to education without improving quality or employability may fail to reduce crime. Some studies even report a positive relationship between education and crime in contexts where educated unemployment is prevalent (Rahmalia et al., 2019). This finding challenges the conventional assumption that education universally reduces crime.

2.4. Unemployment and Crime

Unemployment is consistently identified as a significant driver of crime. Theoretical models suggest that individuals without stable income sources face higher incentives to engage in illegal activities (Becker, 1968). Empirical studies confirm a robust, positive relationship between unemployment and crime across countries (Raphael & Winter-Ebmer, 2001). In Indonesia, unemployment contributes to economic insecurity and social instability, which can increase criminal activity (Pohan, 2020; Mervita et al., 2022). Structural factors such as slow economic growth, labor market mismatches, and technological change further exacerbate unemployment (Sukirno, 2000; Nanga, 2001). However, the unemployment–crime relationship is not uniform. Some studies indicate that its impact depends on demographic characteristics, social policies, and local economic conditions (Mocan & Rees, 2005). This suggests that unemployment interacts with other variables, such as education and poverty, rather than acting as an isolated determinant.

Empirical research on crime has increasingly adopted panel data methods to capture temporal and regional variation. Dynamic panel models allow researchers to account for persistence in crime rates and potential endogeneity between variables (Arellano & Bond, 1991; Baltagi, 2021). These methods are particularly relevant in analyzing crime, which often exhibits strong temporal dependence. Despite methodological advancements, many studies in Indonesia

still rely on static models that ignore dynamic effects and potential reverse causality. This limitation reduces the reliability of estimated relationships and may lead to biased conclusions. Few studies apply advanced econometric techniques, such as the Generalized Method of Moments, to address these issues. The literature reveals three key insights. First, poverty, education, and unemployment are widely recognized as major determinants of crime, but their effects are not consistent across contexts. Second, education does not always reduce crime, particularly when labor market conditions are unfavorable. Third, unemployment remains a strong predictor of crime, but its interaction with other socioeconomic variables is often overlooked. Thus, the current study addresses these gaps by integrating economic and social perspectives within a dynamic panel framework. It examines the joint effects of poverty and education on crime while controlling for unemployment. By focusing on Aceh Province, the study also considers the role of regional characteristics in shaping crime dynamics.

3. Materials and Methods

3.1. Data Sources

This study was conducted in Aceh Province to examine the influence of poverty and education on crime rates. The analysis focuses on key socioeconomic variables, namely poverty, education, and unemployment, with unemployment included as a control variable. The study uses quarterly panel data covering the period from 2019 to 2023, including all four quarters (Q1–Q4), across 23 districts and cities in Aceh Province. The research relies on secondary, panel-structured data. Data were obtained from official sources. Poverty level was measured by average years of schooling, and the open unemployment rate (TPT) was sourced from Badan Pusat Statistik (BPS). Crime data were obtained from the Indonesian National Police's Electronic Investigation Management system. Due to differences in reporting frequency, poverty and education data were interpolated to match the quarterly structure. In this study, poverty and education are treated as independent variables, crime rate as the dependent variable, and unemployment as a control variable. To ensure clarity and consistency, the operational definitions of variables are specified as follows. Poverty refers to the number of individuals living below the poverty line in each district or city, expressed as the number of persons. Education is defined as the average number of years of schooling completed by residents aged 15 years and above, measured in years. The crime rate is measured by the number of reported criminal cases based on type "B" police reports filed by affected parties. Unemployment is defined as the percentage of the working-age population that is not in the labor force.

3.2. Data Analysis

This study uses a dynamic panel regression model to examine relationships among variables. The model integrates cross-sectional and time-series dimensions, allowing for a comprehensive analysis of crime dynamics across districts and over time. A lagged dependent variable is included to capture persistence in crime rates. To address endogeneity and potential bias arising from the inclusion of lagged variables, the study employs the Generalized Method of Moments (GMM) estimator developed by Arellano and Bond (1991). This method uses internal instruments derived from lagged values of the variables and removes individual-specific effects through first-difference transformation. It is also robust to heteroscedasticity and autocorrelation. The selection of the GMM approach is based on two main considerations. First, the dataset is dynamic, and there is a potential bidirectional relationship between crime and explanatory variables, particularly unemployment. Second, GMM provides efficient and consistent estimates in the presence of endogeneity and unobserved heterogeneity.

3.2.1. Panel Data Model

The general panel data regression model follows Baltagi (2021) and is expressed as:

$$y_{it} = \delta y_{i,t-1} + X'_{it}\beta + u_{it}, i = 1,2,\dots,N;\ t = 1,2,\dots,T, \quad (1)$$

Where y_{it}represents the dependent variable for unit $i$at time t, $y_{i,t-1}$is the lagged dependent variable, $X_{it}$is a vector of independent variables, $\beta$is a vector of coefficients, and u_{it} is the error term capturing unobserved effects.

3.2.2. Dynamic Panel Regression Model

Given the dynamic nature of socioeconomic variables, the model includes a lagged dependent variable to capture persistence. The empirical specification is defined as:

$$CT_{it} = \delta CT_{i,t-1} + \beta_1 POV_{it} + \beta_2 SCH_{it} + \beta_3 TPT_{it} + u_{it}, \quad (2)$$

Where CT_{it} denotes the crime rate, $CT_{i,t-1}$ is the lagged crime rate, POV_{it} represents poverty, SCH_{it} denotes education (average years of schooling), and TPT_{it} represents the open unemployment rate. β denotes the estimated coefficients, and u_{it} is the error term.

3.2.3. Generalized Method of Moments (GMM) Estimation

The inclusion of a lagged dependent variable introduces endogeneity because it is correlated with the error term. To address this issue, the study applies the Generalized Method of Moments (GMM), specifically the System GMM (SYS-GMM) estimator developed by Blundell and Bond (1998). The First-Difference GMM (FD-GMM) approach removes individual fixed effects through differencing and uses lagged levels as instruments. However, this approach may lose efficiency when variables exhibit high persistence. System GMM improves estimation efficiency by combining equations in first differences and levels, using lagged differences as instruments for level equations and lagged levels for differenced equations. According to Roodman (2009), GMM is appropriate under several conditions. First, the data consist of many cross-sectional units and relatively few time periods. Second, the model includes a dynamic dependent variable influenced by past values. Third, there is potential endogeneity among explanatory variables. Fourth, unobserved individual effects are present. Fifth, the data may exhibit heteroscedasticity and autocorrelation. Given these characteristics, the System GMM approach is suitable for estimating the effects of poverty, education, and unemployment on crime rates in Aceh Province. This method provides consistent and efficient estimates while accounting for dynamic relationships and correcting for endogeneity bias.

4. Results

4.1. Descriptive Statistics

Descriptive statistics are used to provide an overview of the distributions and key characteristics of the main variables examined: Crime Rate (CT), Poverty (POV), Average Years of Schooling (SCH), and the Open Unemployment Rate (TPT). The dataset covers the quarterly period from the first quarter of 2019 (Q1) to the fourth quarter of 2023 (Q4), comprising 460 observations. The statistics reported include the mean, minimum, maximum, and standard deviation for each variable. To capture aggregate patterns, descriptive measures are calculated from average values across all districts and cities in Aceh Province for each quarter during the study period. The variables analyzed include the number of crime cases (CT), the number of individuals living below the poverty line (POV), the average years of schooling (SCH), and the unemployment rate (TPT). The aggregated quarterly results for all districts and cities in Aceh Province are presented in Table 1.

Table 1. Result of Descriptive Statistics (2019Q1–2023Q4)

Variable(s)	Percentage	Percentiles	Smallest		
	1%	0	0		
	5%	9	0		
	10%	15	0	Obs	460
	25%	31	0	Sum of wgt	460
	50%	55		Mean	79.01304
CT (unit of quantity)			Largest	Std. dev.	73.50562
	75%	107	381		
	90%	170.5	382	Variance	54.07
	95%	212	397	Skewness	1.969
	99%	377	425	Kurtosis	7.552
	1%	51.4	5140		
	5%	12.16	5140		
	10%	14.21	5140	Obs	460
	25%	19.29	5140	Sum of wgt	460
POV (unit of quantity)	50%	28.96		Mean	35.18
			Largest	Std. dev.	24.43
	75%	39.32	108.5		
	90%	63.33	1093	Variance	5.87
	95%	87.95	1094	Skewness	1.497
	99%	10.87	110.5	Kurtosis	4.708
SCH (yearly)	1%	7.645	7.437		

Variable(s)	Percentage	Percentiles	Smallest		
	5%	8.042	7.485		
	10%	8.285	7.532	Obs	460
	25%	8.676	7.58	Sum of wgt	460
	50%	9.126		Mean	9.46
			Largest	Std.dev	1.166
	75%	9.95	13.03		
	90%	11.13	13.03	Variance	1.36
	95%	11.23	13.03	Skewness	1.09
	99%	13.03	13.04	Kurtosis	3.934
	1%	1.11	1.03		
	5%	1.926	1.037		
	10%	2.735	1.045	Obs	460
	25%	4.155	1.052	Sum of wgt	460
	50%	5.937		Mean	5.873
TPT (%)			Largest	Std.dev	2.252
	75%	7.436	11.76		
	90%	8.476	11.78	Variance	5.071
	95%	9.132	11.99	Skewness	0.605
	99%	11.74	12.135	Kurtosis	2.769

Table 1 presents descriptive statistics for the main variables, namely crime rate (CT), poverty (POV), education (SCH), and open unemployment rate (TPT), based on 460 quarterly observations from 2019Q1 to 2023Q4 across 23 districts and cities in Aceh Province. The statistics include measures of central tendency, dispersion, and distribution shape, which provide an initial understanding of the data characteristics before econometric estimation. The crime rate (CT) shows substantial variability across regions and time. The mean value is 79.01 cases, with a high standard deviation of 73.51, indicating significant dispersion. The distribution is positively skewed, as reflected by a skewness value of 1.969, suggesting that most districts report relatively low crime levels, while a smaller number experience very high crime rates. This is further confirmed by the percentile distribution, where the median is 55 cases, but the 90th percentile rises sharply to 170.5 cases, and the 99th percentile reaches 377 cases. The presence of extreme values is also evident from the maximum observation of 425 cases. The kurtosis value of 7.552 indicates a leptokurtic distribution, meaning that the data exhibit heavy tails and a high concentration of extreme observations. These characteristics imply that crime is unevenly distributed across Aceh, with certain districts acting as hotspots. This heterogeneity is important for subsequent analysis, as it suggests that aggregate averages may mask localized crime dynamics.

The poverty variable (POV) also demonstrates considerable variation, with a mean of 35.18 and a standard deviation of 24.43. The distribution is positively skewed (skewness = 1.497), indicating that most districts have relatively lower poverty levels, while a smaller number experience significantly higher poverty concentration. The percentile structure supports this pattern. The median is 28.96, while the 90th percentile increases to 63.33, and the 95th percentile reaches 87.95. This spread indicates substantial inequality in poverty distribution across districts. The kurtosis value of 4.708 suggests a moderately leptokurtic distribution, indicating that extreme poverty levels occur more frequently than expected under a normal distribution. These findings highlight structural disparities within Aceh, where poverty is concentrated in specific areas rather than evenly distributed. The education variable (SCH), measured by average years of schooling, shows a more stable, less dispersed pattern than crime and poverty. The mean value is 9.46 years, with a relatively low standard deviation of 1.17, indicating that educational attainment is fairly consistent across districts. The distribution is moderately positively skewed (skewness = 1.090), suggesting that most regions cluster around the average level, with a few districts achieving higher educational attainment. The percentile values show that the median is 9.13 years, while the 75th percentile is 9.95 years, and the 95th percentile reaches 11.23 years.

The maximum value of 13.04 years indicates that only a limited number of districts achieve high levels of schooling. The kurtosis value of 3.934 indicates a distribution close to normal but with slight tail heaviness. Overall, education appears more evenly distributed than poverty and crime, although disparities still exist, particularly at the upper end. The open unemployment rate (TPT) presents a relatively balanced distribution compared to the other variables. The mean unemployment rate is 5.87 percent, with a standard deviation of 2.25, indicating moderate variation across districts. The skewness value of 0.605 suggests a slight positive skew, meaning that higher unemployment rates are less frequent but still present in certain regions. The median value is 5.94 percent, which is close to the mean, indicating a relatively symmetric distribution. The percentile values show that most districts fall within a moderate range, with the 25th percentile at 4.16 percent and the 75th percentile at 7.44 percent. However, extreme cases exist, as indicated by

the maximum value of 12.14 percent. The kurtosis value of 2.769 suggests a distribution close to normal, with fewer extreme outliers compared to the crime and poverty variables. Thus, the descriptive statistics reveal three important patterns.

First, crime and poverty exhibit high variability and strong right-skewed distributions, indicating significant regional disparities and the presence of extreme cases. Second, education shows relatively low dispersion, suggesting more uniform access across districts, although differences remain. Third, unemployment displays moderate variation with a near-normal distribution, indicating that labor market conditions are relatively consistent across regions but still contain pockets of high unemployment. These findings provide important preliminary insights for the subsequent econometric analysis. The presence of skewness and kurtosis in several variables suggests potential non-normality, which may affect estimation results. Moreover, the substantial heterogeneity across districts underscores the importance of using panel data methods that can capture both cross-sectional and temporal variations.

4.2. Validity Testing

Instrument validity is a central requirement in the Generalized Method of Moments framework because it ensures that the instruments are exogenous and uncorrelated with the error term. The Sargan test is applied to evaluate the overall validity of the instruments used in the model. The null hypothesis (H_0) states that all instruments are valid, meaning they satisfy the orthogonality condition with the residuals. Failure to reject this hypothesis indicates that the instrument set is appropriate and that the estimated coefficients are consistent and unbiased.

Table 2. Result of Validity Testing

Sargan Test	Use Variable Control		Without Variable Control	
	FD-GMM	**SYS-GMM**	**FD-GMM**	**SYS-GMM**
chi2	17.6581	18.8830	17.9423	21.0387
prob > chi2	1.0000	1.0000	1.0000	1.0000

Table 2 presents the results of the Sargan test for both estimation approaches, namely First-Difference GMM (FD-GMM) and System GMM (SYS-GMM), under two model specifications: with control variables and without control variables. The chi-square (χ^2) statistics for the models with control variables are 17.6581 for FD-GMM and 18.8830 for SYS-GMM. Similarly, for the models without control variables, the χ^2 values are 17.9423 for FD-GMM and 21.0387 for SYS-GMM. These values reflect the joint significance of the instruments used in each specification. More importantly, the probability values (p-values) associated with all four models are equal to 1.0000. This result is substantially higher than conventional significance levels such as 1 percent, 5 percent, or 10 percent. Therefore, the null hypothesis cannot be rejected in any specification. This outcome indicates that the instruments used in both FD-GMM and SYS-GMM models are valid and do not suffer from over-identification.

The consistency of results across both model specifications strengthens the instrument set's robustness. Whether control variables are included or excluded, the instruments' validity remains intact. This suggests that the model specification is stable and that the chosen instruments adequately capture the endogenous structure of the variables without introducing bias. From a methodological perspective, these findings confirm that the GMM estimators used in this study satisfy the key assumption of instrument exogeneity. As a result, the estimated relationships between poverty, education, unemployment, and crime can be interpreted with a high degree of confidence. The validity of the instruments also supports the reliability of subsequent inference and policy recommendations derived from the model. Thus, the Sargan test results demonstrate that all instruments are statistically valid across all specifications. This provides strong evidence that the dynamic panel model is correctly specified and suitable for analyzing the determinants of crime in Aceh Province.

4.3. Consistency Testing

The Arellano–Bond test is applied to assess the presence of serial correlation in the residuals of the first-differenced dynamic panel model. Within the Generalized Method of Moments framework, the absence of second-order autocorrelation is a critical requirement for model consistency. First-order autocorrelation is expected due to the transformation of variables into first differences and does not indicate model misspecification.

Table 3. Result of Consistency using Arellano Bond Testing

A-B Test	Statistic	With Control Variables (FD-GMM)	With Control Variables (SYS-GMM)	Without Control Variables (FD-GMM)	Without Control Variables (SYS-GMM)
AR(1)	z-value	-2.1206	-2.1159	-2.0734	-2.1724
	Prob > z	0.034	0.0344	0.0381	0.0298
AR(2)	z-value	-2.488	-2.3969	-2.2211	-2.1582
	Prob > z	0.0128	0.0165	0.0263	0.0309

Table 3 reports the results of the Arellano–Bond test for both First-Difference GMM (FD-GMM) and System GMM (SYS-GMM), under specifications with and without control variables. For the AR(1) test, all models show statistically significant results. The z-values range from −2.0734 to −2.1724, with corresponding p-values between 0.0298 and 0.0381. These results indicate the presence of first-order autocorrelation in the residuals. This outcome is expected and consistent with the theoretical properties of the first-difference transformation. Therefore, the AR(1) results do not raise concerns regarding model validity. For the AR(2) test, which is the critical condition for model consistency, all models also show statistically significant results. The z-values range from −2.1582 to −2.488, with p-values between 0.0128 and 0.0309. These findings indicate the presence of second-order autocorrelation in the residuals at the 5 percent significance level. The presence of AR(2) autocorrelation suggests that the instruments used in the model may not fully eliminate serial correlation, potentially affecting the consistency of the estimators. This issue may arise from model specification, the choice of lag structure, or the persistence of the variables included in the analysis.

Despite this limitation, the magnitude of the test statistics and their consistency across both FD-GMM and SYS-GMM models indicate that the issue is relatively moderate rather than severe. In practice, dynamic panel models may tolerate limited deviations from the ideal assumptions, particularly when other diagnostic tests, such as instrument validity, are satisfied. Thus, the Arellano–Bond test results highlight a partial violation of the no second-order autocorrelation assumption. This finding suggests caution when interpreting the estimation results. Further refinement of instrument selection or model specification may improve consistency. However, given that the instrument validity test has been satisfied and the model's theoretical structure remains sound, the estimates can still provide meaningful insights into the relationships among poverty, education, unemployment, and crime in Aceh Province.

4.4. Estimator Testing

Estimator testing assesses whether the selected estimation techniques produce consistent and unbiased coefficient estimates. This step is essential in dynamic panel analysis because different estimators may yield divergent results due to heterogeneity, endogeneity, and model specification. Table 4 compares the lagged coefficients of the dependent variable (crime rate, CT) obtained from four estimators, namely the Fixed Effects Model (FEM), First-Difference GMM (FD-GMM), System GMM (SYS-GMM), and the Constant Effects Model (CEM), under specifications with and without control variables. From a theoretical perspective, FEM is often used as a benchmark because it controls for unobserved individual heterogeneity. In contrast, CEM assumes homogeneity across cross-sectional units and is therefore prone to bias, particularly when omitted variables or dynamic effects are present.

Table 4. Result of Estimator Testing

Estimator	With Control Variables	Without Control Variables
FEM	−0.0674	−0.1106*
FD-GMM	−0.0721***	−0.11976***
SYS-GMM	−0.0076	−0.0079
CEM	0.5899***	0.6424***

Note: *** p < 0.01, * p < 0.10.

In the model with control variables, FEM produces a coefficient of −0.0674, indicating a negative relationship between past and current crime rates. The FD-GMM estimator yields a coefficient of −0.0721, which is statistically significant at the 1 percent level and closely aligns with the FEM estimate. This similarity suggests that FD-GMM provides consistent and reliable estimates. In contrast, SYS-GMM produces a coefficient of −0.0076, which is statistically insignificant and substantially different from the FEM benchmark. This result indicates that SYS-GMM fails to capture the data's dynamic structure under this specification accurately. Meanwhile, CEM generates a coefficient of 0.5899, which is positive and statistically significant. This result clearly reflects an upward bias, consistent with theoretical expectations, as CEM ignores individual heterogeneity and dynamic effects. A similar pattern is observed in

the model without control variables. FEM yields a coefficient of −0.1106, while FD-GMM produces a slightly larger, but consistent, estimate of −0.11976, both of which are statistically significant. This reinforces FD-GMM's robustness as an estimator that closely approximates the FEM benchmark. SYS-GMM again produces a near-zero and statistically insignificant coefficient (−0.0079), indicating weak performance in capturing the true relationship. CEM continues to show a strong positive bias, with a coefficient of 0.6424, further confirming its inconsistency in this context. The comparison across estimators reveals three key findings. First, FD-GMM consistently produces estimates closest to FEM, indicating high reliability and minimal bias. Second, SYS-GMM fails to provide accurate estimates in this dataset, likely due to issues related to instrument proliferation or weak instruments. Third, CEM produces systematically biased results due to its restrictive assumptions. Based on these findings, FD-GMM is identified as the most appropriate estimator for this study. It effectively addresses endogeneity, controls for unobserved heterogeneity, and yields unbiased, statistically significant estimates. Therefore, its use as the primary estimation method for analyzing the effects of poverty and education on crime in Aceh Province is methodologically justified.

4.5. Hypothesis Testing

Table 5 reports the results of the dynamic panel estimation using the First-Difference Generalized Method of Moments estimator. The results indicate that poverty (POV), education (SCH), and the open unemployment rate (TPT) exert statistically significant effects on the crime rate (CT) at the 1 percent level. The inclusion of the lagged dependent variable allows the model to capture persistence in crime dynamics and to distinguish between short-term and long-term effects.

Table 5. Results of Short-Term and Long-Term Direct Effects (With Control Variables)

Variables	Coefficient	Std. Error	P-Value	Short-Term Effect	Long-Term Effect
CT (t−1)	-0.072	0.012	0.000	-0.072	–
POV	-0.006	0.000	0.000	-0.006	-0.006
SCH	79.390	4.359	0.000	79.390	74.060
TPT	14.540	1.290	0.000	14.540	13.560
Wald Chi²	= 25.460				
Prob > Chi²	= 0.000				

The dynamic estimation results in Table 5 reveal that the coefficient of the lagged crime variable, CT_{t-1}, is −0.072 and statistically significant, indicating that current crime levels are negatively associated with past crime rates. This finding suggests the presence of an adjustment mechanism rather than persistence, in which a reduction follows higher crime in the previous period. Such a pattern may reflect corrective responses, including intensified law enforcement, policy interventions, or community adaptation. The lagged coefficient also plays a crucial role in deriving long-term effects within the dynamic model framework. The effect of poverty on crime is negative and statistically significant in both the short term and long term, with a coefficient of −0.006. This result implies that an increase in poverty is associated with a marginal decrease in crime rates. This finding contradicts conventional economic theory, which predicts that poverty increases the likelihood of criminal behavior. In the context of Aceh, this inverse relationship suggests that poverty does not function as a direct determinant of crime. Instead, local factors such as strong social cohesion, religious norms, and informal community control mechanisms may suppress criminal behavior despite economic hardship. The consistency of the coefficient across time horizons indicates that this effect is persistent. However, the relatively small magnitude suggests that poverty has a limited explanatory role compared to other variables.

Education exhibits a strong positive and statistically significant relationship with crime. The short-term coefficient is 79.390, while the long-term effect decreases slightly to 74.060. These results indicate that higher average years of schooling are associated with increased crime rates. This finding challenges the human capital perspective, which assumes that education reduces crime by enhancing legal income opportunities. The observed positive relationship may reflect a structural mismatch between education and labor-market conditions. Individuals with higher educational attainment may face limited employment opportunities, leading to dissatisfaction and increased incentives for deviant behavior. Although the long-term coefficient is slightly lower, the effect remains substantial and persistent, indicating that the issue is structural rather than temporary. The open unemployment rate also shows a positive and statistically significant effect on crime. The short-term coefficient is 14.540, and the long-term coefficient is 13.560, indicating that higher unemployment is associated with higher crime rates. This result is consistent with economic theory, which links unemployment to reduced legal income and higher incentives for illegal activities. The relatively large coefficient suggests that unemployment is a dominant factor in explaining variations in crime. The persistence of this effect in the long term further indicates that labor market conditions play a structural role in shaping criminal behavior.

The overall model demonstrates strong statistical significance, as indicated by the Wald Chi-square value of 25.460 and a probability of 0.000. This confirms that the explanatory variables jointly provide a robust explanation of crime variations across districts and over time. Thus, the findings highlight three key points. Unemployment has the strongest and most consistent positive effect on crime, emphasizing the importance of labor market conditions. Education shows an unexpected positive relationship with crime, suggesting inefficiencies in translating educational attainment into economic outcomes. Poverty exhibits a negative but relatively weak effect, indicating that social and institutional factors mediate its influence. Overall, the results demonstrate that crime in Aceh is driven more by structural and institutional dynamics than by poverty alone. The model's dynamic nature further confirms that these relationships persist over time, underscoring the need for integrated policies that link education, employment, and social cohesion.

Next, Table 6 presents the estimation results of the dynamic panel model without including control variables. The findings indicate that both poverty (POV) and education (SCH) have statistically significant effects on crime (CT) at the 1 percent level. The model also includes the lagged dependent variable, which captures the dynamic adjustment of crime over time.

Table 6. Results of Short-Term and Long-Term Direct Effects (Without Control Variables)

Variables	Coefficient	Std. Error	P-Value	Short-Term Effect	Long-Term Effect
CT (t−1)	-0.072	0.007	0.000	-0.072	–
POV	-0.008	0.001	0.000	-0.008	-0.007
SCH	66.765	5.087	0.000	66.765	59.630
Wald Chi²	= 3915.440				
Prob > Chi²	= 0.000				

The coefficient of the lagged crime variable, CT_{t-1}, is −0.072 and statistically significant. This result suggests that past crime rates negatively influence current crime levels. The negative sign indicates an adjustment mechanism, where a reduction follows higher crime in the previous period in the current period. This may reflect adaptive responses such as increased law enforcement, deterrence effects, or community-based interventions. The magnitude of the coefficient is consistent with the model that includes control variables, indicating stability in the dynamic structure of crime. The poverty variable shows a negative and statistically significant relationship with crime. The short-term coefficient is −0.008, while the long-term effect is slightly smaller at −0.007. This indicates that increases in poverty are associated with a reduction in crime rates. Although the magnitude is relatively small, the effect is consistent and persistent across time horizons. This finding deviates from standard economic theory, which predicts a positive relationship between poverty and crime. In this context, the results suggest that poverty may not be a direct driver of criminal activity. Instead, it may be moderated by social and institutional factors such as community cohesion, informal control mechanisms, and cultural norms that discourage deviant behavior even under economic constraints.

Education has a strong, positive, and statistically significant effect on crime. The short-term coefficient is 66.765, and the long-term effect is 59.630. This indicates that higher average years of schooling are associated with increased crime rates. Although the magnitude is slightly lower compared to the model with control variables, the direction and significance remain unchanged. This result challenges the traditional human capital perspective, which assumes that education reduces crime by improving economic opportunities. The positive relationship observed here may reflect structural issues, particularly the mismatch between educational attainment and labor market absorption. Individuals with higher education may experience limited employment opportunities, leading to dissatisfaction and a higher propensity for deviant behavior. The reduction in the long-term coefficient suggests some adjustment over time, but the effect remains substantial. The overall model is highly significant, as indicated by a Wald Chi-square value of 3915.440 and a p-value of 0.000. This confirms that the explanatory variables jointly provide strong explanatory power in capturing variations in crime across districts and over time, even in the absence of control variables.

Thus, the results without control variables support the study's main findings. The dynamic nature of crime is evident, as shown by the significant lagged effect. Poverty maintains a negative but limited influence on crime, while education continues to exhibit a strong positive relationship. The consistency of these results with the model that includes control variables suggests robustness in the estimated relationships. However, omitting unemployment as a control variable may overestimate the effects of poverty and education, underscoring the importance of incorporating labor market factors in a comprehensive analysis of crime determinants.

5. Discussion

This study examines the determinants of crime in Aceh Province by focusing on poverty, education, and unemployment within a dynamic panel framework. The results provide several important insights that both align with and challenge existing theoretical and empirical literature. The discussion integrates these findings with established theories to clarify the mechanisms underlying crime dynamics in developing regions. The dynamic specification reveals

a negative and significant coefficient for the lagged crime variable. This indicates that crime does not exhibit persistence in a conventional sense but instead follows an adjustment pattern over time. Such a finding suggests that institutional responses, including law enforcement and community interventions, may help stabilize crime levels. This outcome is consistent with the argument that crime is influenced by policy effectiveness and deterrence mechanisms rather than purely structural factors (Levitt, 2004). It also supports dynamic panel evidence that crime behavior evolves and cannot be adequately captured using static models (Arellano & Bond, 1991; Baltagi, 2021).

The relationship between poverty and crime presents a notable deviation from conventional economic theory. The results indicate a negative and statistically significant effect of poverty on crime in both the short term and long term. Traditional frameworks, particularly the economic theory of crime, predict a positive relationship because economic deprivation increases incentives for illegal activities (Becker, 1968). Empirical studies in Indonesia and other developing countries generally support this view (Rahmalia et al., 2019; Dulkiah & Nurjanah, 2018; Putra et al., 2021). However, the findings of this study contradict these expectations and instead align with research suggesting that poverty does not universally lead to higher crime rates (Dong et al., 2020; Mocan & Rees, 2005). The specific socio-cultural context of Aceh can explain this inverse relationship. Strong religious values, customary institutions, and community-based social control mechanisms characterize the region. These factors may reduce the likelihood of criminal behavior even under economic hardship. Similar arguments have been advanced in studies that emphasize the role of informal institutions and social cohesion in mitigating crime (Kleck et al., 2001; Levitt, 2004). Therefore, poverty in Aceh appears to be mediated by non-economic factors, suggesting that economic deprivation alone is insufficient to explain crime patterns.

The findings on education provide further evidence of the complexity of crime determinants. Contrary to the predictions of human capital theory, education shows a positive and significant relationship with crime. Theoretically, education should reduce crime by increasing legal income opportunities and improving decision-making (Becker, 1968; Moretti, 2004). Empirical studies also support the crime-reducing effect of education, particularly in contexts where education enhances employability (Machin et al., 2011; Mustofa & Suryadarma, 2018). However, the results of this study align with emerging evidence that education can increase crime under certain conditions. When educational attainment rises without corresponding improvements in labor market opportunities, it may generate frustration and unmet expectations (Fella & Gallipoli, 2014). This mismatch between education and employment has been identified as a key factor driving deviant behavior in developing economies (Machin & Meghir, 2004). In the Aceh context, the positive relationship between education and crime likely reflects structural inefficiencies in the labor market, where educated individuals face limited employment prospects. This finding suggests that education alone is not sufficient to reduce crime unless it is aligned with economic opportunities.

Unemployment emerges as the most consistent and influential determinant of crime in this study. The positive and significant relationship between unemployment and crime supports the core predictions of economic theory, which links joblessness to reduced legal income and increased incentives for illegal activities (Becker, 1968). This finding is consistent with a large body of empirical literature demonstrating that unemployment is a key driver of crime (Raphael & Winter-Ebmer, 2001; Pohan, 2020; Mervita et al., 2022). The magnitude and persistence of the unemployment effect indicate that labor market conditions play a structural role in shaping crime dynamics. Unlike poverty, which appears to be moderated by social factors, unemployment directly affects individuals' economic capacity and may lead to immediate behavioral responses. This distinction highlights the importance of differentiating between various forms of economic hardship when analyzing crime.

The comparison between models with and without control variables further strengthens the robustness of the findings. The consistency in the direction and significance of coefficients suggests that the relationships identified are stable and not driven by model specification. However, the absence of unemployment in the model without control variables slightly alters the magnitude of the coefficients, indicating that labor market conditions interact with both poverty and education in influencing crime. This supports the argument that crime is determined by a combination of interrelated socioeconomic factors rather than a single variable (Sari & Azhar, 2019; Putra et al., 2021). From a methodological perspective, dynamic panel estimation offers important advantages over conventional approaches. By accounting for endogeneity and temporal dependence, the model produces more reliable estimates of causal relationships. This approach addresses limitations identified in previous studies that rely on static models and fail to capture the dynamic nature of crime (Arellano & Bond, 1991; Blundell & Bond, 1998). The validity and estimator tests further confirm the robustness of the results, supporting their relevance for policy analysis.

6. Conclusions

This study investigates the dynamic relationship between poverty, education, unemployment, and crime in Aceh Province using a panel data approach. The results demonstrate that a single factor does not drive crime; rather, crime emerges from the interaction of economic conditions, labor market structures, and social dynamics. The findings show that poverty has a negative and statistically significant relationship with crime, indicating that economic deprivation alone does not necessarily increase criminal behavior in Aceh. This result reflects the moderating role of social

cohesion, religious norms, and informal institutions. In contrast, education exhibits a positive and significant effect on crime, suggesting that increased educational attainment does not automatically reduce criminal activity when it is not aligned with labor market opportunities. Unemployment emerges as the most influential determinant, with a strong and consistent positive effect on crime in both the short and long term. These results highlight that labor market constraints and structural inefficiencies play a central role in shaping crime dynamics.

The dynamic specification further confirms that crime adjusts over time rather than exhibiting strong persistence, indicating the presence of corrective mechanisms such as enforcement and social responses. Overall, the study provides evidence that crime in Aceh is influenced more by structural and institutional factors than by poverty alone.

6.1. Research Limitations

Several limitations should be acknowledged. First, the study relies on secondary data, which may not fully capture unreported or informal criminal activities. Crime data are based on official reports, which may underestimate actual crime levels. Second, the model focuses on a limited set of variables. Other important determinants, such as income inequality, urbanization, law enforcement effectiveness, and demographic factors, are not included due to data constraints. Third, although the dynamic panel model addresses endogeneity, the presence of second-order autocorrelation suggests that the model may not fully satisfy all statistical assumptions. This may affect the precision of the estimates. Fourth, the analysis is confined to Aceh Province. While this provides valuable context-specific insights, the findings may not be directly generalizable to other regions with different socioeconomic and institutional characteristics.

6.2. Policy Implications

The results offer several important policy implications. First, crime-reduction strategies should not rely solely on poverty-alleviation programs. While poverty remains a social concern, its direct impact on crime appears limited in this context. Second, education policy requires structural reform. Increasing access to education is insufficient if improvements in quality and alignment with labor market needs do not accompany it. Strengthening vocational education, technical skills training, and industry linkages is essential to reducing the mismatch between education and employment. Third, employment creation should be prioritized as a core crime prevention strategy. The strong effect of unemployment on crime suggests that expanding job opportunities, particularly for young and educated individuals, can significantly reduce crime. Policies that promote labor-intensive industries, entrepreneurship, and regional economic development are critical. Fourth, the role of social and cultural institutions should be strengthened. Community-based approaches, including the involvement of religious and customary leaders, can enhance informal social control and contribute to crime prevention.

6.3. Recommendations for Future Research

Future studies should expand the scope of analysis by incorporating additional variables such as income inequality, urbanization, demographic structure, and institutional quality to provide a more comprehensive understanding of crime determinants. Further research should also consider using mixed-method approaches that combine quantitative analysis with qualitative insights. This would allow for a deeper exploration of the social and cultural factors that influence crime behavior. In addition, future studies should examine regional comparisons across provinces in Indonesia to assess whether the findings observed in Aceh are consistent in other contexts. Cross-country studies may also provide broader insights into the relationship between socioeconomic factors and crime. Finally, improvements in data quality and availability are essential. Developing more comprehensive datasets that include information on unreported crime and law enforcement effectiveness would enhance the accuracy and robustness of future analyses.

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Author Initials:
I.I.: Indra Ismawan
T.Z.: Teuku Zulham
S.S.: Suriani Suriani

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