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ORIGINAL ARTICLE

Provincial Evidence: Long-Run Impact of Human Development Indicators on Poverty Gap and Severity

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Abstract

This study aims to fill the identified gap by examining the long-run impact of human development indicators on the poverty gap and severity index in Aceh Province, Indonesia. Utilizing data from the period 2010-2022 and various methodologies such as Fully-Modified OLS (FMOLS), Dynamic OLS (DOLS), and Canonical Cointegration Regressions (CCR), the econometric results indicate that three out of four human development indicators—spending per capita, expected years of schooling, and mean years of schooling—significantly impact poverty gap and severity. However, it was found that the relationships are positive, which means that an increase in human development level worsens poverty. This empirical evidence suggests that human development indicators in Aceh Province have yet to be optimized for successful poverty alleviation. Therefore, policy recommendations for policymakers should focus on bolstering education accessibility, promoting economic empowerment initiatives, and enhancing the effectiveness of existing poverty alleviation programs in Aceh Province.

Introduction

Human development, encompassing factors like education, healthcare, and economic opportunities, serves as both a driver and outcome of poverty alleviation [1–4]. Poverty constrains human development by limiting access to essential energy resources and opportunities, perpetuating cycles of deprivation [5–10]. Conversely, improved human development indicators, such as literacy rates and healthcare access, contribute to poverty reduction by empowering individuals to break out of poverty traps, fostering economic growth, and enhancing social resilience [11–14].

The poverty gap and poverty severity are essential measures used to assess the depth and intensity of poverty within a population. The poverty gap measures the average shortfall of the poor from the poverty line, indicating how far below the poverty threshold they fall on average [15]. Poverty severity, on the other hand, captures the extent to which individuals or households fall below the poverty line, accounting for both the depth and distribution of poverty within a society [16]. Both measures are closely intertwined with human development, as they reflect not only economic deprivation but also the inadequacy of essential human capabilities, such as education, healthcare, and access to basic amenities.

Indonesia has seen improvements in various human development indicators, including education and healthcare [17–19]. The government has been investing in education and healthcare infrastructure to improve access and quality of services across the country [20–22]. However, disparities still exist between urban and rural areas, as well as across different regions of the archipelago [23,24]. Meanwhile, Indonesia has made significant strides in poverty reduction over the years [25,26]. However, poverty remains a significant challenge, particularly in rural areas and among certain demographics such as indigenous populations and those living

in remote regions [27,28]. Efforts to alleviate poverty have been ongoing, including social assistance programs and initiatives to improve access to education and healthcare[29–31].

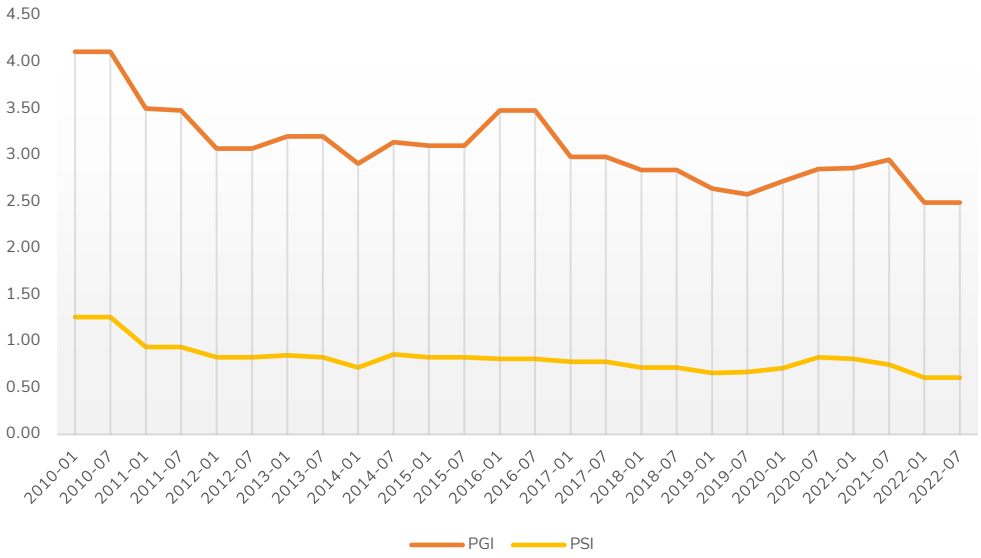

Figure 1. Poverty Gap Index (PGI) and Poverty Severity Index (PSI) of Aceh Province 2010-2022. (Source: Statistics of Aceh Province)

Aceh Province, Indonesia, has a complex history that has greatly impacted the growth of the provincial economy, including a devastating tsunami in 2004 and a prolonged separatist conflict. While the province has made strides in recovery and development since then, pockets of poverty still persist. Factors such as geographic isolation, limited infrastructure, and environmental vulnerabilities exacerbate poverty in certain areas and make poverty alleviation in the region a challenge to be solved [32,33].

The phenomena of poverty in Aceh Province, as indicated by the poverty gap index (PGI) and poverty severity index (PSI), demonstrate a declining trend from 2010 to 2022. As illustrated in Figure 1, Aceh Province's PGI declined from above four points in 2010 to below three points in 2022. Similarly, the PSI trend for Aceh Province decreased from above one point in 2010 to below one point in 2022. Despite the decreasing trend observed in PGI and PSI numbers, the level of poverty gap and severity remains unacceptably high. Additionally, data from the Statistics of Indonesia reveals that in 2023, Aceh Province ranked as the 6th poorest province in Indonesia and stood 1st in the Sumatra region, with approximately 26 million people living below the poverty line.

Government and non-governmental organizations have implemented various social welfare programs aimed at addressing poverty in Aceh Province. These programs include cash transfer schemes, food assistance, healthcare initiatives, and vocational training programs to empower disadvantaged communities [34–37]. However, the effectiveness of these programs depends on their accessibility and sustainability. Moreover, as improving education is crucial for poverty alleviation, efforts have been made to enhance access to education in Aceh Province. However, challenges remain and keep hindering the effort, including limited resources, inadequate infrastructure, and a shortage of qualified teachers, particularly in remote areas [38–41].

Previous studies globally provide robust evidence of the significant influence of human development factors on poverty. Some notable studies, such as that by Arimah [42], which conducted empirical analysis in Africa, reveal that inter-country differences in poverty levels can be accounted for by variables indicative of different facets of human development, including education and health aspects. Furthermore, a study by Minh [43] based on a sample of 40

developing economies found that the population below the poverty line is connected to all human development indicators including education, health, and spending per capita. Additionally, a study by Francisco [44], based on a survey of different forms of inequalities in Southeast Asia, found systemic barriers to a more equitable distribution of opportunities in income, education, and health, which consequently worsen the poverty situation.

Considerable prior studies in Indonesia regarding the relationship between human development and poverty have already been conducted. Some of the latest research, such as the study by Dahliah & Nirwana Nur [45], Hasan [46], and Wibowo & Ridha [47], indicates the negative impact of human development on poverty. At the provincial level, recent studies like those by Fahrika et al. in South Sulawesi [48], Amaluddin et al. in Maluku [49], and Amalia et al. in Papua [50], also demonstrate the significant influence of human development in reducing poverty. However, despite numerous specific prior studies in Aceh Province, such as the recent studies by Affandi [51], Yurina & Misla [52], and Triani & Sitorus [53], there has yet to be a study that assesses human development indicators long-run impact, especially concerning poverty gap and severity index in Aceh Province. This existing gap will be the main novelty of this study.

Based on the explanation of the research background, identified problem, and the existing gap that still exists, this study will focus on assessing the long-run impact of human development indicators—namely spending per capita, expected and mean years of schooling, and life expectancy—on poverty gap and severity in Aceh Province, using various dynamic methods. The results of this study will provide more comprehensive empirical evidence about the specific human development aspects that have a direct impact on poverty gap and severity. Consequently, policy formulation for poverty alleviation in Aceh Province can be more strategic.

Materials and Methods

Data and Variables

This study employed yearly time-series data covering the period 2010-2022. The rationale for choosing this period is the availability of poverty gap and severity index data for the Aceh Province between 2010 and 2022. All the data in this investigation was sourced from the Statistics of Aceh Province (BPS Aceh) [54]. Comprehensive details regarding the dependent, independent, and control variables utilized are provided in Table 1.

Econometric Models

The main mathematical function of this study is written as:

$$P_t = f(HD_t, GRDP_t, PD_t) \quad (1)$$

Where P is the poverty gap dan severity index, HD is the human development indicators, $GRDP$ is the gross regional domestic product, and PD is the population density. Thus, the econometric model based on the mathematical function above is written in Equations 2 and 3.

$$PGI_t = \beta_0 + \beta_1 SPC_t + \beta_2 EYS_t + \beta_3 MYS_t + \beta_4 LEB_t + \beta_5 GRDP_t + \beta_6 PD_t + \varepsilon_t \quad (2)$$
$$PSI_t = \beta_0 + \beta_1 SPC_t + \beta_2 EYS_t + \beta_3 MYS_t + \beta_4 LEB_t + \beta_5 GRDP_t + \beta_6 PD_t + \varepsilon_t \quad (3)$$

All variables in Equations 2 and 3 were converted to logarithmic form (ln) and written in Equations 4 and 5.

$$lnPGI_t = \beta_0 + \beta_1 lnSPC_t + \beta_2 lnEYS_t + \beta_3 lnMYS_t + \beta_4 lnLEB_t + \beta_5 lnGRDP_t + \beta_6 PD_t + \varepsilon_t \quad (4)$$
$$lnPSI_t = \beta_0 + \beta_1 lnSPC_t + \beta_2 lnEYS_t + \beta_3 lnMYS_t + \beta_4 lnLEB_t + \beta_5 lnGRDP_t + \beta_6 PD_t + \varepsilon_t \quad (5)$$

Here, t is the study timeframe, β_o is the intercept, β_1–β_6 is the coefficients, and ε is the error term.

Table 1. Definition of variables.

Variable Name (Symbol)	Units (Sources)	Definition of Variable
Dependent		
Poverty Gap Index (PGI)	Value Points	The measures of the average income shortfall of the poor from the poverty line.
Poverty Severity Index (PSI)	Value Points	The measures not only quantify the average income shortfall of the poor from the poverty line but also weight this shortfall by its squared value.
Independent as Explanatory		
Spending per Capita (SPC)	Rupiah	Refers to the average amount of money spent per person within a specified population.
Expected Years of Schooling (EYS)	Years	Estimates the number of years of schooling a child of school-entry age can expect to receive if prevailing patterns of educational enrollment continue
Mean Years of Schooling (MYS)	Years	Represents the average number of years of education received by adults in a population.
Life Expectancy at Birth (LEB)	Years	The measures of the average number of years a newborn can expect to live.
Independent as Control		
Gross regional domestic product (GRDP)	Constant 2010	The measure of the total economic output produced within a specific province over a certain period.
Population Density (PD)	Person	The measure of the number of people living in a given area, expressed as the number of individuals per unit of land area (square kilometers).

Methods

This study employed three methods to generate long-run impact: Fully Modified OLS (FMOLS), Dynamic OLS (DOLS), and Canonical Cointegration Regression (CCR). FMOLS is a method for estimating cointegrating relationships in time series data by adjusting OLS estimates to account for endogeneity and serial correlation [55,56]. DOLS is another technique that incorporates lagged variables to mitigate potential issues with serial correlation and endogeneity when estimating cointegrating regressions [55,56]. CCR is an alternative approach that transforms original variables into orthogonal ones to estimate cointegrating vectors without pre-testing for unit roots or determining the cointegration rank [55,56]. These methods are all designed to provide consistent parameter estimates for cointegrating relationships in time-series analysis.

Results and Discussion

Descriptive Statistics

The descriptive statistics in Table 2 provides an overview of the distributional characteristics of the variables. Across the dataset utilized, the mean and median values for each variable are relatively close, suggesting symmetric distributions for most of the variables. For instance, PGI, PSI, EYS, MYS, LEB, and PD exhibit narrow gaps between their mean and median values, indicating relatively balanced distributions. However, for GRDP, there is a slightly larger gap between the mean and median, implying a potential skewness in the distribution.

Table 2. Descriptive Statistics.

Variable	Mean	Median	Maximum	Minimum	Std. Dev.
PGI	3.08	3.03	4.11	2.49	0.42
PSI	0.82	0.81	1.26	0.61	0.16
SPC	8828.59	8768.00	9963.00	7933.73	668.57
EYS	13.79	13.89	14.37	12.90	0.53
MYS	8.86	8.86	9.44	8.28	0.41
LEB	69.56	69.51	70.18	69.08	0.34
GRDP	23.72	23.23	26.066	22.45	1.15
PD	87.87	88.84	94.27	78.85	5.15

Furthermore, standard deviations provide information on the dispersion of data points around the mean, with lower standard deviations indicating less variability and higher standard deviations suggesting greater dispersion. Notably, PD demonstrates the highest standard deviation, indicating a wider spread of values compared to other variables. Overall, these descriptive statistics offer a comprehensive understanding of the central tendency, variability, and range of the variables in the dataset.

Unit Root Test

The Phillips-Perron test is conducted to detect the presence of a unit root problem in the data. As shown in Table 3, all variables indicate stationarity in the first difference order. This implies that there are no unit root problems, and the variability of the data remains consistent over time. Based on the results of this test, it can be concluded that the employed methods can be applied.

Table 3. The results of Phillips-Perron unit root test.

Variable	Prob.	
	Level	1st Difference
PGI	0.2724	0.0002**
PSI	0.1365	0.0003**
SPC	0.9695	0.0000**
EYS	0.3213	0.0000**
MYS	0.9049	0.0000**
LEB	0.9889	0.0000**
GRDP	0.9880	0.0001**
PD	0.2543	0.0000**

Note: ** indicate significant at 5%

Cointegration Test

A cointegration examination is conducted to evaluate if a group of variables is cointegrated, facilitating the utilization of the DOLS, FMOLS, and CCR methodologies. In this investigation, the Johansen cointegration test is applied. As depicted in Table 4, the model displays robust and statistically noteworthy cointegration for up to six postulated numbers of cointegrations at a 1% significance level. This outcome confirms the claim that the dynamic estimation techniques employed in this study unveil a persistent long-run association among the variables.

Table 4. The results of Johansen cointegration test.

Model	Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.
PGI	None	0.9999	654.09*	143.67	0.0000
	At most 1	0.9972	375.66*	111.78	0.0000
	At most 2	0.9812	234.35*	83.937	0.0000
	At most 3	0.9289	138.98*	60.061	0.0000
	At most 4	0.7677	75.507*	40.175	0.0000
	At most 5	0.5931	40.477*	24.276	0.0002
	At most 6	0.4937	18.895*	12.321	0.0035
PSI	None	0.9941	367.75*	111.78	0.0000
	At most 1	0.9779	244.52*	83.937	0.0000
	At most 2	0.9602	152.95*	60.061	0.0000
	At most 3	0.7677	75.572*	40.175	0.0000
	At most 4	0.5911	40.536*	24.276	0.0002
	At most 5	0.4952	19.079*	12.321	0.0032

Note: * indicate significant at 1%

The Long-Run Impact of Human Development Indicators on Poverty Gap

The econometric results for the long-run impact of human development indicators on the poverty gap, as shown in Table 5, indicate that two of the four indicators have a significant

positive influence on the PGI: SPC and MYS variables. SPC is significant at the 1% probability level in all methods, while MYS is at the 5% probability level based on FMOLS and CCR methods. Furthermore, control variables GRDP and PD also exert strong significance toward PGI, both with negative coefficients. Meanwhile, all indicators for the dependent variable, as simultaneously varied by independent variables, indicate excellent outcomes across all methods, where R-squared and adjusted R-squared values are >70%, indicating a good fit for the model. Additionally, the standard error of regression and long-run variance value are <0.1, indicating that the long-run examination results are stable and reliable.

Specifically, the findings reveal that a 1.0% increase in the SPC variable correlates with a rise in the PGI by 2.7102%, 3.2063%, and 2.7215% based on FMOLS, DOLS, and CCR, respectively. In a similar way, a 1.0% increase in the MYS variable also contributes to an escalation in the PGI by 3.5335% and 3.6421% based on FMOLS and CCR. Conversely, a 1.0% increase in GRDP is associated with a decrease in the PGI by 2.6149%, 2.6678%, and 2.5748% based on FMOLS, DOLS, and CCR, respectively. Furthermore, a 1.0% increase in PD is linked to a reduction in the PGI by 6.7809%, 6.1999%, and 6.6362% based on FMOLS, DOLS, and CCR, respectively.

Table 5. The results of FMOLS, DOLS, and CCR for the long-run impact of human development indicators on poverty gap.

Dependent Variable: PGI				
Independent Variables		**FMOLS**	**DOLS**	**CCR**
Constant		56.443 (1.1174)	91.288 (1.2272)	58.344 (1.1162)
SPC		2.7102 (3.0162)*	3.2063 (2.5504)**	2.7215 (3.1924)*
EYS		2.5629 (0.8189)	1.6739 (0.3563)	2.2384 (0.6181)
MYS	Coeff. (t-stat.)	3.5335 (2.2795)**	3.6979 (1.6318)	3.6421 (2.1944)**
LEB		-13.143 (-0.9976)	-22.527 (1.1629)	-13.652 (1.0112)
GRDP		-2.6149 (4.8582)*	-2.6678 (3.3673)*	-2.5748 (4.5782)*
PD		-6.7809 (3.9242)*	-6.1999 (2.4163)**	-6.6362 (3.3718)*
R-squared		0.8294	0.8691	0.8278
Adjusted R-squared		0.7726	0.8278	0.7704
Standard error of regression		0.0561	0.0539	0.0563
Long-run variance		0.0013	0.0031	0.0013

Note: *, **, and *** indicate significant at 1%, 5%, and 10%

The Long-Run Impact of Human Development Indicators on Poverty Severity

As illustrated in Table 6, the results of the econometric analysis concerning the effects of human development indicators on poverty severity indicate that three of the four indicators—namely, SPC, EYS, and MYS variables—positively influence PSI significantly. SPC demonstrates significance at the 1% probability level, MYS at the 5% probability level, and EYS at the 10% probability level across all methods. Moreover, control variables GRDP and PD also demonstrate notable significance towards PSI, both exhibiting negative coefficients. Concurrently, all indicators related to the dependent variable, as influenced by independent variables, reveal highly favorable outcomes across all methodologies, with R-squared and adjusted R-squared values >70%, thus indicating an excellent model fit. Additionally, the standard error of regression and long-run variance values <0.1 signified the stability and reliability of the long-run examination results.

In specific explanation, the outcomes reveal that a 1.0% increase in the SPC variable correlates with a rise in the PSI by 3.5255%, 3.8766%, and 3.4492% based on FMOLS, DOLS, and CCR,

respectively. Similarly, a 1.0% increase in the EYS variable correlates with an increase in the PSI by 10.521%, 9.3546%, and 10.762% based on FMOLS, DOLS, and CCR, respectively. Also, in a similar way, a 1.0% increase in the MYS variable contributes to an uptick in the PSI by 4.1347%, 4.2441%, and 4.1421% based on FMOLS, DOLS, and CCR, respectively. On the contrary, a 1.0% increase in GRDP is correlated with a decrease in the PSI by 2.4345%, 2.4929%, and 2.4001% based on FMOLS, DOLS, and CCR, respectively. Furthermore, a 1.0% increase in PD is linked to a reduction in the PSI by 13.916%, 13.282%, and 14.063% based on FMOLS, DOLS, and CCR, respectively.

Table 6. The results of FMOLS, DOLS, and CCR for the long-run impact of human development indicators on poverty severity.

Dependent Variable: PSI				
Independent Variables		**FMOLS**	**DOLS**	**CCR**
Constant	Coeff. (t-stat.)	68.477 (1.0342)	86.772 (1.1499)	65.792 (0.9148)
SPC		3.5255 (2.9937)*	3.8766 (3.0395)*	3.4492 (2.9867)*
EYS		10.521 (2.5648)**	9.3546 (1.9629)***	10.762 (2.2048)**
MYS		4.1347 (2.0352)***	4.2441 (1.8461)***	4.1421 (1.8842)***
LEB		-15.879 (0.9196)	-20.905 (1.0638)	-15.107 (-0.8121)
GRDP		-2.4345 (3.4509)*	-2.4929 (3.1017)*	-2.4001 (3.2471)*
PD		-13.916 (6.1444)*	-13.282 (5.1023)*	-14.063 (5.3102)*
R-squared		0.8556	0.8918	0.8547
Adjusted R-squared		0.8075	0.8576	0.8063
Standard error of regression		0.0659	0.0653	0.0661
Long-run variance		0.0023	0.0031	0.0023

Note: *, **, and *** indicate significant at 1%, 5%, and 10%

Discussion

Understanding the relationship between human development indicators and poverty dynamics is crucial for policymakers aiming to design effective poverty alleviation strategies. In Aceh Province, where socio-economic development has been influenced by various factors including spending per capita, education, life expectancy, economic growth, and population density, examining the long-run impact of these indicators on poverty metrics becomes imperative. The human development framework posits that economic growth alone does not guarantee improvements in human well-being. Instead, a comprehensive approach considering indicators such as education, health, and income is essential for measuring and addressing poverty [57].

The findings of this study, across various dynamic methods, reveal several noteworthy insights into the dynamics of poverty in Aceh Province. Firstly, the long-run impact of spending per capita and mean years of schooling on the poverty gap underscores the critical role of education and economic resources in reducing income disparities. This aligns with previous research emphasizing the importance of education and income generation in poverty alleviation efforts [58,59]. Secondly, the long-run impact of spending per capita, expected years of schooling, and mean years of schooling on poverty severity underscores the multifaceted nature of poverty. Investments in education not only enhance individuals' earning potential but also contribute to overall societal well-being by fostering human capital development [60,61]. Thirdly, the positive correlation between significant human development indicators impact on poverty gap and severity, which contradicts the theoretical expectation that the more people spend their income in consumption and the more they have a higher education level should decrease the

poverty gap and severity, indicates that the human development aspect for poverty alleviation in Aceh Province is not yet optimized.

Furthermore, the negative long-run impact of GRDP and population density on both poverty gap and poverty severity suggests that rapid provincial economic growth and urbanization may not necessarily translate into equitable distribution of wealth and opportunities. This finding resonates with the notion of "growth without development," highlighting the importance of inclusive growth strategies that prioritize social welfare and address provincial disparities [62].

The study underscores the importance of adopting a holistic approach to poverty alleviation, one that goes beyond mere economic indicators to encompass broader dimensions of well-being such as access to healthcare, social protection, and environmental sustainability. By acknowledging the multidimensional nature of poverty and its underlying determinants, policymakers can design more effective strategies that promote inclusive growth, empower marginalized populations, and foster sustainable development in Aceh Province.

Conclusions

Across all long-run regression methods used to assess the impact of human development indicators on poverty in Aceh Province, it is concluded that three out of four indicators significantly impact the poverty gap and severity. The human development indicators of spending per capita and mean years of schooling have a positive long-run impact on the poverty gap. Similarly, the human development indicators of spending per capita, expected years of schooling, and mean years of schooling also positively impact poverty severity in the long run. In concrete conclusion, the economic and educational aspects of human development are proven to significantly affect the gap and severity of poverty in Aceh Province. The positive correlation between them, which contradicts theoretical expectations, indicates that human development in Aceh Province has yet to be optimized.

Based on the findings, it is evident that a strategic policy approach is needed to address the multifaceted nature of the relationship between human development and poverty in Aceh Province. Firstly, policymakers must prioritize investments in education and economic resources, which are essential to reduce income disparities and alleviate poverty, as evidenced by the significant long-run impacts of spending per capita and mean years of schooling on the poverty gap. Secondly, recognizing the interplay between education, income generation, and poverty severity underscores the importance of holistic interventions by the provincial government that enhance both individual earning potential and societal well-being. Lastly, the observed positive correlation between human development indicators and poverty gap/severity highlights the need to optimize strategies for human capital development in poverty alleviation efforts. Therefore, policy recommendations should focus on bolstering education accessibility, promoting economic empowerment initiatives, and enhancing the effectiveness of existing poverty alleviation programs in Aceh Province.

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