https://doi.org/10.7251/EMC2602468A
UDK: 316.323.6:330.101.541(497-15)
Datum prijema rada: 19. januar 2026.
Submission Date: January 19, 2026
Datum prihvatanja rada: 30. jun 2026.
Acceptance Date: June 30, 2026
Časopis za ekonomiju i tržišne komunikacije
Economy and Market Communication Review
Godina/Vol. **XVI** • Br./No. **II**
str./pp. 468-489

ORIGINALNI NAUČNI RAD / ORIGINAL SCIENTIFIC PAPER

HUMAN DEVELOPMENT IN THE WESTERN BALKANS: A PANEL ANALYSIS OF GROSS DOMESTIC PRODUCT, LIFE EXPECTANCY, AND SOCIOECONOMIC INEQUALITIES

Imran Aslan Prof. Dr., Health Management Department, Faculty of Health Science, Bingöl University, Selahaddin-i Eyyubi, Üniversite Caddesi No:1, Türkiye, imranaslan@gmail.com; iaslan@bingol.edu.tr; ORCID ID: 0000-0001-5307-4474

Darijana Antonić Prof. Dr., Paneuropean University "Apeiron" Banja Luka, Faculty of Health Sciences, Pan-European University Apeiron, Banja Luka, Banja Luka, Bosnia and Herzegovina; Public Health Institute of the Republic of Srpska, Centre for Health System Development and International Cooperation, Banja Luka, Bosnia and Herzegovina, darijana.b.antonic@apeiron-edu.eu; darijana.a@gmail.com; ORCID ID: 0000-0002-6656-1885

Milka Stojkić MSc, Public Health Institute of the Republic of Srpska, Centre for Health System Development and International Cooperation, Banja Luka Bosnia and Herzegovina, milka.stojkic@phi.rs.ba; ORCID ID: 0009-0005-1724-4401

Slobodan Stanić Prof. Dr., Faculty of Pharmaceutical and Health Sciences, Travnik, Bosnia and Herzegovina; Public Health Institute of the Republic of Srpska, Centre for Health System Development and International Cooperation, Banja Luka, Bosnia and Herzegovina, slobodanstanic63@yahoo.com; ORCID ID: 0009-0007-7118-6833

Abstract: *This study examines the statistical associations among gross domestic product per capita (GDP per capita), life expectancy at birth, income inequality, inequality in life expectancy, and human development across five Western Balkan countries. The analysis utilizes secondary data from the United Nations Development Programme's Human Development Reports and the United Nations Statistics Division.*

The results indicate that, in 2022, Montenegro and Serbia are classified within the very high human development category, while Albania, Bosnia and Herzegovina, and North Macedonia remain in the high human development category. Correlation analysis demonstrates a positive association between the Human Development Index (HDI) and GDP per capita, and negative associations between HDI and both income inequality and inequality in life expectancy. The association between HDI and life expectancy is relatively weak. Fixed-effects panel regression results show that GDP per capita, life expectancy, and income inequality are not statistically significantly associated with HDI. In contrast, inequality in life expectancy exhibits a negative association with HDI that approaches statistical significance. These results should be interpreted as statistical associations rather than causal relationships.

Keywords: *Human Development Index (HDI), GDP per capita, life expectancy, income inequality, life expectancy inequality*

JEL classification: *O15; I14; I18; D63; C23*

INTRODUCTION

The concept of development is inherently multidimensional, encompassing economic performance, quality of life, health outcomes, education, and overall social well-being. In recent decades, development has increasingly been framed within the paradigm of sustainable development, which integrates economic growth, environmental protection, and social equity. This approach seeks to reduce the negative effects of rapid population growth, industrialization, food insecurity, ecosystem degradation, urbanization, energy insecurity, and environmental deterioration on long-term development. Within this context, the Human Development Index (HDI) has emerged as a widely used composite indicator that provides an overview of human development across regions and countries (Abdussamad et al., 2024; Khan, Ju & Hassan, 2019; Singh & Kumar, 2022).

The HDI captures three core dimensions of human development. The health dimension is measured by life expectancy at birth, reflecting population well-being and access to healthcare services. Education is assessed through expected years of schooling and mean years of schooling, capturing both current and accumulated educational attainment. The standard of living dimension is measured using gross national income or gross regional domestic product per capita, adjusted for purchasing power parity and transformed logarithmically to account for diminishing marginal utility of income as income levels rise (Human Development Index, 2025; Kurian, 2011; Sasmita et al., 2024).

Government expenditure on social services represents an important investment in public goods such as healthcare, education, and infrastructure, all of which contribute directly to improvements in HDI outcomes (Abdussamad et al., 2024). Beyond its core components, the HDI is associated with broader aspects of development, including energy consumption, business activity, economic growth, disaster management capacity, and democratic quality (Ladi, Mahmoudpour & Sharifi, 2021; Sasmita et al., 2024). Social development is influenced by the old-age dependency ratio, education expenditure, female infant mortality, female labour force participation, gender ratios, and life expectancy at birth, while economic development depends on exports, consumption, foreign direct investment, capital formation, and GDP per capita (Singh & Kumar, 2022).

Over the past two decades, developing countries have experienced relatively strong economic growth, sometimes exceeding that of developed economies (Amponsah et al., 2023). However, this growth has not consistently reduced poverty or inequality, largely due to weak governance and ineffective domestic policies (World Bank, 2022). Although the HDI offers valuable insights, it remains a summary indicator that cannot fully capture income inequality, multidimensional poverty, and individual empowerment (Human Development Index, 2025). The assumption that economic growth automatically improves well-being has therefore been questioned.

Against this background, the present study addresses gaps in the literature on the relationships among GDP per capita, life expectancy, income inequality, and life expectancy inequality. While HDI research is extensive globally, studies focusing on Western Balkan countries remain limited. This study combines correlation and difference analysis to examine changes in HDI and its socioeconomic determinants in Western Balkan countries between 2010 and 2022, aiming to inform targeted development strategies and evidence-based policymaking to improve regional quality of life. The findings are intended to support policymakers in designing inclusive, equitable, and sustainable development interventions across diverse socioeconomic contexts and institutional settings.

LITERATURE REVIEW

The Human Development Index (HDI) is a key indicator encompassing multiple dimensions of human welfare, including health, education, and living standards, and provides a more comprehensive perspective on development than economic indicators alone (Akar et al., 2021). As a composite index, the HDI measures the average level of achievement in three fundamental dimensions of human development: a long and healthy life, access to knowledge, and an adequate standard of living (Cheng et al., 2022). By encapsulating these core dimensions, the HDI offers a holistic framework for assessing national development across countries and over time.

Each component of the HDI is measured using specific indicators. The health dimension is assessed through life expectancy at birth, reflecting the overall health status of the population and the effectiveness of healthcare systems. Education is measured using expected years of schooling and mean years of schooling, capturing both current educational opportunities and accumulated human capital. The standard of living dimension is measured by gross national income (GNI) per capita, adjusted for purchasing power parity (PPP), which allows for international comparability of real income levels. These indicators are normalized and aggregated into a single composite score, ensuring that no single dimension dominates the overall index (Human Development Index (HDI), 2021; Kurian, 2011; Ladi, Mahmoudpour & Sharifi, 2021). By integrating diverse measures, the HDI provides a more nuanced understanding of national well-being than reliance on income-based indicators alone.

Recent research has expanded the conceptual scope of the HDI by incorporating additional variables such as environmental health, income disparity, and satellite-observed night-time light intensity, further strengthening its ability to reflect real living conditions (Qiu et al., 2018). Developing reliable public infrastructure in transportation, education, and healthcare remains crucial for improving human capital quality and reducing poverty. Human resources play a central role in economic growth and poverty reduction, as workforce quality directly affects productivity and income generation. Consequently, low HDI levels may perpetuate cycles of low productivity, poor living standards, and persistent poverty (Nurjihan & Faizi, 2024).

Despite the positive and statistically significant relationship between GDP and HDI observed in many empirical studies, this relationship does not always accurately reflect the economic development realities of Western Balkan countries. Measuring economic performance solely through GDP per capita has been widely criticized, as it does not account for labor market participation or productivity distribution (Amponsah

et al., 2023). GDP per employed person has been proposed as a more accurate indicator of inclusive economic participation, as it reflects individuals' direct engagement in and benefit from economic activity (Campos-Vazquez et al., 2017; Koh et al., 2020). This measure is particularly relevant for assessing progress toward inclusive and sustainable economic development, where growth should translate into broader social benefits rather than concentrated gains (Ianchovichina & Lundstrom, 2009).

Economic growth, when accompanied by rising inequality, may fail to reduce poverty effectively. Empirical evidence suggests that inclusive growth measured by GDP per capita may be positively associated with higher inequality, indicating that economic expansion does not necessarily improve income distribution or expand opportunities for disadvantaged groups (Campos-Vazquez et al., 2017; Koh et al., 2020). These findings highlight the limitations of GDP-centric development models and reinforce the importance of human development indicators such as the HDI.

GROSS DOMESTIC PRODUCT (GDP) PER CAPITA

Gross domestic product (GDP) per capita remains one of the most commonly used indicators of economic development, measuring average economic output per person. When adjusted for PPP, GDP per capita enables more accurate comparisons of living standards across countries (Human Development Index, 2025). It is calculated by dividing total GDP by the mid-year population and can be measured using output, expenditure, or income approaches at current or constant prices. While GDP per capita is often interpreted as an indicator of economic growth and national prosperity, its relationship with poverty and inequality is complex. Although GDP growth has been shown to reduce poverty levels on average, its benefits are unevenly distributed across population groups (Cheng et al., 2022; Dahliah & Nur, 2021; Dritsaki & Dritsaki, 2023; Taqi et al., 2021). Therefore, equitable development policies are necessary to ensure that improvements in GDP translate into broad-based welfare gains.

Human development and economic growth are mutually reinforcing. Economic growth provides the resources necessary for investments in health, education, and social protection, while higher levels of human development enhance labor productivity and innovation, thereby supporting further growth. Numerous studies confirm a strong positive correlation between GDP per capita and HDI across countries (Islam, 1995; Hung, 2022; Taqi et al., 2021). However, the strength of this relationship varies across development levels, with the strongest correlation observed in countries with low human development, where marginal income gains generate substantial improvements in health and education outcomes (Deb, 2015).

Hypothesis 1: *Higher GDP per capita is associated with higher HDI.*

INEQUALITY IN INCOME

Income inequality represents another critical determinant of human development. The relationship between income inequality and HDI has gained increasing attention in development economics, as economic growth alone does not guarantee equitable improvements in well-being (Castells-Quintana et al., 2018). Rising GDP does not necessarily imply better health, education, or shared prosperity, particularly when growth benefits are concentrated among higher-income groups (Ladi et al., 2021). The World Inequality Report (WIR, 2019) emphasizes the importance of income distribu-

tion in shaping development outcomes. To understand multidimensional poverty, it is essential to examine how income inequality influences HDI performance (Günay & Topbaş, 2021).

Income inequality is commonly measured using the Gini coefficient, which reflects the degree of income concentration within a society (Cheng et al., 2022; Dahliah & Nur, 2021; Dritsaki & Dritsaki, 2023). Higher Gini values indicate greater inequality, while lower values signal more equitable income distribution (Triani & Sitorus, 2023). Empirical evidence consistently shows a negative relationship between income inequality and HDI, suggesting that unequal income distribution limits access to health, education, and economic opportunities (Faisal, 2022). Moreover, inequality negatively affects human capital accumulation and long-term economic growth. Studies such as Ghifara et al. (2022) demonstrate that higher HDI levels can significantly reduce income inequality in metropolitan regions.

Hypothesis 2: *Greater income inequality negatively affects HDI.*

LIFE EXPECTANCY

Life expectancy at birth is a core component of the HDI and a widely used indicator of healthcare system effectiveness. It measures the expected number of years a newborn would live under prevailing mortality conditions (Cheng et al., 2022). Life expectancy reflects cumulative health outcomes influenced by nutrition, sanitation, medical technology, and access to healthcare services (Kurian, 2011; Triani & Sitorus, 2023). Countries with high HDI scores typically exhibit higher life expectancy due to advanced healthcare systems, improved living standards, and better educational attainment. In contrast, low-HDI regions face constrained healthcare access, poor nutrition, and weaker public health infrastructure, resulting in lower life expectancy (Lind, 2021).

Empirical studies confirm strong positive correlations between life expectancy and HDI (Human Development Index, 2025). Research conducted in Indonesia shows that life expectancy, income per capita, education, and expenditure are all significantly correlated with HDI (Abdussamad et al., 2024; Sasmita et al., 2024). Improvements in healthcare infrastructure, sanitation, and clean water access are critical determinants of life expectancy and indirectly enhance HDI outcomes (Girum et al., 2018).

Hypothesis 3: *Higher life expectancy is positively associated with HDI.*

INEQUALITY IN LIFE EXPECTANCY

Inequality in life expectancy further deepens disparities in human development. Life expectancy inequality reflects differences in survival outcomes across income groups and regions and serves as an objective measure of social and health inequality (WHO, 2025). Although life expectancy has increased globally, disparities persist due to lifestyle differences, unequal healthcare access, and socioeconomic conditions (Lind, 2021). Countries with higher HDI values tend to exhibit narrower life expectancy gaps, while low-HDI countries display significant disparities driven by income inequality, gender gaps, and regional inequalities.

The HDI plays a crucial role in identifying and addressing life expectancy inequalities by linking health outcomes to education and income conditions. Enhancing HDI components contributes to more equitable health outcomes and reduced life

expectancy gaps. Empirical evidence indicates that rising HDI levels are associated with declining life expectancy inequality, supporting the role of human development in fostering more equitable and sustainable societies (Lind, 2021).

Hypothesis 4*: Greater life expectancy inequality negatively affects HDI.*

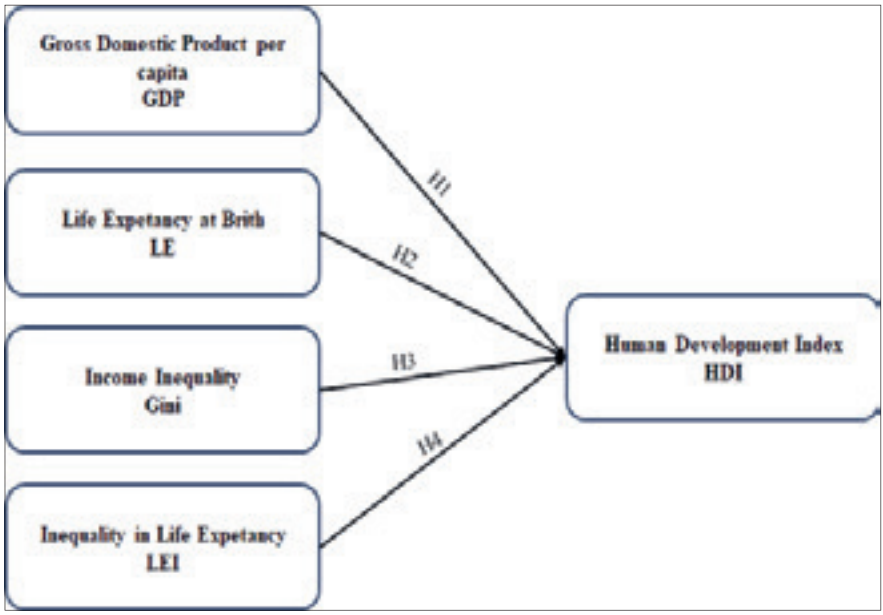

Figure 1: Conceptual framework
Source: Authors

Building on the theoretical insights and empirical evidence reviewed above, this study develops a conceptual framework that links key socioeconomic factors to human development outcomes Figure 1.

METHODOLOGY

Data description

Secondary data were obtained from the United Nations Development Programme's Human Development Reports (United Nations Development Programme, 2024) and the United Nations Data platform (United Nations Statistics Division, 2024). The analysis focuses on five Western Balkan countries: Albania, Bosnia and Herzegovina, Montenegro, North Macedonia, and Serbia. While the broader reference period spans 2010 to 2022, the regression analysis utilizes data from five specific years: 2010, 2015, 2020, 2021, and 2022. The resulting balanced panel comprises 25 country-year observations, representing five countries across five selected years. The dataset contains one dependent variable and four independent variables. Only observations with complete data for all variables included in the model were retained. No interpolation, imputation, or aggregation across missing years was performed. Table 1 provides descriptions of the variables and data sources.

Table 1. Variable definition

Variable	Type	Description	Unit	Source
HDI	DV	Human Development Index	Index (0-1)	Human Development Reports (UNDP) https://hdr.undp.org/data-center/documentation-and-downloads)
GDP	IV	Gross Domestic Products per capita	USD per capita (constant prices)	UN Data https://data.un.org/
LE	IV	Life Expectancy at Birth	Years	UN Data https://data.un.org/
Gini	IV	Income Inequality	Index (0-100)	UN Data https://data.un.org/
LEI	IV	Inequality in Life Expectancy	Years	UN Data https://data.un.org/

Note: DV is the dependent variable. IV is the independent variable
Source: Authors

GDP per capita serves as an indicator of economic performance and is reported in constant USD by the United Nations Data platform. While the Human Development Index (HDI) standard-of-living dimension relies on gross national income (GNI) per capita, GDP per capita was chosen for this analysis due to its consistency and availability across the selected Western Balkan countries and years. Consequently, GDP per capita is employed as an external proxy for economic performance rather than as the precise income component of the HDI. Income inequality is measured by the Gini coefficient, with higher values indicating greater income disparities. Inequality in life expectancy reflects differences in survival outcomes among population groups. As the variables were sourced from different United Nations-related data platforms, potential differences in indicator definitions, estimation procedures, and harmonisation methods are recognised. Nevertheless, these sources offer internationally comparable data suitable for cross-country analysis.

DIAGNOSTIC TESTING AND DATA SUSTAINABILITY

To ensure the reliability and robustness of the panel regression analysis, the dataset was subjected to a series of diagnostic tests assessing key statistical assumptions. These included Skewness and Kurtosis tests for normality, the Variance Inflation Factor (VIF) for multicollinearity, White's test for heteroskedasticity, Cameron and Trivedi's Information Matrix (IM) test, and the Hausman specification test.

The Skewness and Kurtosis tests indicate that none of the variables included in the model—HDI, GDP per capita, life expectancy at birth, income inequality, and inequality in life expectancy—exhibit statistically significant deviations from normality. These results confirm that the normality assumption is satisfied (see Appendix A, Table A1).

The VIF results reveal no evidence of problematic multicollinearity. All VIF values fall well below commonly accepted thresholds, with a mean VIF of 2.37, indicating only moderate correlations among the explanatory variables (see Appendix A, Table A2). Consequently, the assumption of no severe multicollinearity is met.

White's test for heteroskedasticity fails to reject the null hypothesis of homoskedasticity ($p = 0.2755$), suggesting that the error terms exhibit constant variance across

observations (see Appendix A, Table A3).

These findings are further supported by Cameron and Trivedi's IM test, which indicates no evidence of heteroskedasticity or non-normality. None of the test components is statistically significant, and the overall test fails to reject the null hypothesis. It confirms that the residuals satisfy the assumptions of homoskedasticity and normality, reinforcing the robustness of the estimated model (see Appendix A, Table A4).

Overall, the diagnostic results demonstrate that the assumptions of normality, homoskedasticity, and absence of multicollinearity are satisfied, supporting the validity of the panel regression framework. Finally, the Hausman specification test strongly rejects the null hypothesis of no systematic difference between the fixed- and random-effects estimators ($p = 0.0000$). It indicates that the fixed-effects model provides consistent estimates and is therefore the preferred specification for the analysis (see Appendix A, Table A5).

ECONOMETRIC MODEL AND ESTIMATION FRAMEWORK

This study examines the relationship between key socioeconomic and health-related indicators and the Human Development Index (HDI) in Western Balkan countries. Human development is conceptualized as a function of economic performance, health outcomes, and inequality dimensions, thereby reflecting its multidimensional character (Neumayer, 2001).

The explanatory variables selected for analysis are GDP per capita (GDP) as a proxy for economic prosperity, life expectancy at birth (LE) as an indicator of population health, income inequality measured by the Gini coefficient (Gini), and inequality in life expectancy (LEI), which captures disparities in survival outcomes. An important methodological consideration is the conceptual overlap between the dependent variable and certain explanatory variables. The Human Development Index (HDI) is a composite measure that includes a health dimension, assessed by life expectancy at birth, and a standard-of-living dimension, assessed by gross national income (GNI) per capita. Therefore, including life expectancy and GDP per capita in the model may introduce a partial mechanical association with HDI. In this analysis, GDP per capita is treated as an external indicator of economic performance rather than as a direct substitute for the GNI component of HDI. Life expectancy is included to assess the relationship between the health dimension and overall human development in the Western Balkan countries.

Accordingly, the regression results are interpreted as statistical associations rather than causal effects. The model is intended to explore associations between economic performance, average population health, income inequality, inequality in life expectancy, and HDI across countries and selected years, rather than to establish causality. As a result, the findings should be interpreted with caution due to potential conceptual overlap, simultaneity, and endogeneity.

The econometric model is specified as follows:

$$HDI_{it} = \beta_0 + \beta_1 GDP_{it} + \beta_2 LE_{it} + \beta_3 Gini_{it} + \beta_4 LEI_{it} + \mu i + \varepsilon_{it} \qquad (1)$$

Source: Authors' specification based on standard panel regression models from Baltagi (2021) and Wooldridge (2010).

In this context, I denotes the country, and t denotes the time. μ_i represents unobserved country-specific effects, while ε_it denotes the idiosyncratic error term.

The model is estimated under the standard assumption that the explanatory variables are not correlated with the contemporaneous error term. However, due to the composite structure of the Human Development Index (HDI) and the potential simultaneity among human development, health, and economic performance, this assumption requires careful interpretation. Consequently, the results are interpreted as associational rather than causal, consistent with the limitations inherent in the fixed-effects panel regression framework (Wooldridge, 2010; Baltagi, 2021).

Panel Data Structure

The analysis employs a balanced short panel dataset comprising five Western Balkan countries observed over the period 2010–2022. Panel data techniques are utilized to exploit both cross-sectional and time-series variation, thereby increasing estimation efficiency and controlling for unobserved heterogeneity across countries (Hsiao, 2014; Baltagi, 2021).

To ensure robustness, three competing econometric specifications are considered: the pooled regression model, the random-effects model, and the fixed-effects model.

Pooled Regression Model

The pooled regression model assumes homogeneity across countries and over time, implying a common intercept and slope coefficients for all cross-sectional units. Under this assumption, the estimation equation is expressed as:

$$HDI_{it} = \beta_0 + \beta_1 GDP_{it} + \beta_2 LE_{it} + \beta_3 Gini_{it} + \beta_4 LEI_{it} + \varepsilon_{it} \qquad (2)$$

Source: Adapted from Baltagi (2021) and Wooldridge (2010).

This specification is appropriate only if cross-sectional units are sufficiently similar and unobserved country-specific effects do not systematically influence human development outcomes. In comparative analyses involving heterogeneous institutional, historical, and socioeconomic contexts, this assumption is rarely satisfied, rendering pooled regression estimates potentially biased and inconsistent (Greene, 2018; Baltagi, 2021). Consequently, unobserved heterogeneity must be explicitly accounted for using appropriate panel-data estimators, such as fixed-effects or random-effects models. Failure to control for country-specific characteristics may lead to misleading inferences regarding the determinants of human development and well-being (Frey & Stutzer, 2000).

Random Effects Model

In the context of panel data, variation arises both **between countries** and **within countries over time**. To account for this structure, the random effects model decomposes the error term as:

$$\varepsilon_{it} = \mu_i + u_{it} \qquad (3)$$

Source: Random-effects error decomposition adapted from Baltagi (2021) and Wooldridge (2010).

where μ_i represents unobserved country-specific effects assumed to be uncorrelated with the explanatory variables, and u_{it} is the idiosyncratic disturbance term. The corresponding random effects specification is given by:

$$HDI_{it} = \beta_0 + \beta_1 GDP_{it} + \beta_2 LE_{it} + \beta_3 Gini_{it} + \beta_4 LEI_{it} + \mu_i + u_{it} \quad (4)$$

Source: Random-effects panel regression specification based on Baltagi (2021) and Wooldridge (2010).

The random-effects estimator is consistent and efficient under the assumption that unobserved country-specific effects are uncorrelated with the explanatory variables, formally expressed as $E(X_{it}\mu_i) = 0$ (Baltagi, 2021; Wooldridge, 2010). If this assumption is violated, the estimates become biased and inconsistent. When it holds, the random-effects model is more efficient than the fixed-effects specification, as it exploits both within- and between-country variation and preserves degrees of freedom, which is particularly advantageous in short panel settings (Schunck, 2013).

Fixed Effects Model

Alternatively, the fixed effects model allows for correlation between unobserved country-specific effects and the explanatory variables. This approach is particularly appropriate when institutional, historical, or structural country characteristics influence both human development outcomes and their determinants, as is often the case in regional development studies (Mundlak, 1978; Hsiao, 2014).

The fixed effects specification is expressed as:

$$HDI_{it} = (\beta_0 + \mu_i) + \beta_1 GDP_{it} + \beta_2 LE_{it} + \beta_3 Gini_{it} + \beta_4 LEI_{it} + u_{it} \quad (5)$$

Source: Fixed-effects panel regression specification adapted from Hsiao (2014), Baltagi (2021), and Wooldridge (2010).

By allowing the intercept to vary across countries, the fixed-effects estimator controls for time-invariant unobserved heterogeneity that could otherwise bias coefficient estimates. This approach is particularly suitable in cross-country development analyses, where latent national characteristics—such as governance quality, cultural norms, or differences in health-care systems—may simultaneously affect the dependent variable and the regressors. Empirical evidence indicates that accounting for such country-specific effects yields more reliable and policy-relevant insights into the relationships between GDP, inequality, and human development (Jaumotte et al., 2013; Jauch & Watzka, 2015; Silva, 2020).

Model Selection Tests

To ensure consistent estimator terminology, three panel-data specifications were considered conceptually: pooled ordinary least squares (OLS), random-effects, and fixed-effects models. The pooled OLS model serves as the baseline, while random- and fixed-effects models account for unobserved country-specific heterogeneity.

The Hausman specification test was used to choose between the random-effects and fixed-effects estimators. The test rejects the null hypothesis of no systematic difference between the estimators, indicating that the fixed-effects model is more appropriate for the data. Consequently, the final regression results reported in Table 4 are based on the fixed-effects specification.

EMPIRICAL RESULTS

According to the HDI 2022 rankings, countries in the Western Balkans exhibit notable differences in human development. Montenegro (HDI = 0.844) and Serbia (HDI = 0.805) are classified in the very high human development category, while Albania (HDI = 0.789), Bosnia and Herzegovina (HDI = 0.779), and North Macedonia (HDI = 0.765) fall in the high human development category (Human Development Reports, 2024).

Table 2 presents the mean values of HDI and the explanatory variables for the period 2010–2022, highlighting substantial socioeconomic and demographic heterogeneity across the region. Average HDI values range from 0.761 in Bosnia and Herzegovina to 0.830 in Montenegro, indicating persistent differences in overall development outcomes among Western Balkan countries.

Table 2. Mean values of the Human Development Index and socioeconomic indicators in Western Balkan countries, 2010–2022

Country	HDI	GDP	LE	Gini	LEI	HDI Rank 2022
Albania	0.784	5253,8	77,97	20,352	6,88	74
Bosnia and Herzegovina	0.761	6012,6	76,01	26,447	4,32	80
Montenegro	0.830	7964,2	76,47	20,694	3,32	50
North Macedonia	0.764	5665,6	74,80	22,712	4,94	83
Serbia	0.795	7087,2	74,79	16,962	4,46	65

Source: Authors

Economic performance, measured by GDP per capita, varies considerably. Montenegro records the highest average GDP per capita (USD 7,964.2), reflecting relatively stronger economic conditions, while Albania exhibits the lowest average value (USD 5,253.8). These disparities suggest unequal economic capacities that may influence long-term trajectories of human development.

In terms of health outcomes, life expectancy at birth also differs across countries. Albania achieves the highest average life expectancy (77.97 years), whereas Serbia records the lowest (74.79 years), indicating uneven progress in population health despite similar regional contexts.

Measures of inequality further reveal structural challenges. Income inequality is most pronounced in Bosnia and Herzegovina (26.447), while Serbia exhibits the lowest inequality (16.962). Additionally, inequality in life expectancy, a critical dimension of health equity, is highest in Albania (6.88 years) and lowest in Montenegro (3.32 years), suggesting substantial differences in the distribution of health outcomes across countries.

Figure 2 illustrates the evolution of HDI across Western Balkan countries from 2010 to 2022, revealing an overall upward trend in human development despite occasional fluctuations. Montenegro consistently outperforms other countries, with HDI increasing steadily from 0.806 in 2010 to 0.844 in 2022, reinforcing its position in the very high human development category.

Serbia follows a similar but more moderate trajectory, showing steady improvements and reaching an HDI of 0.805 in 2022. Albania and Bosnia and Herzegovina show

notable progress over time, although Bosnia and Herzegovina remains at the lower end of the regional HDI distribution, improving from 0.718 in 2010 to 0.779 in 2022.

North Macedonia exhibits a more uneven pattern, with HDI growth slowing after 2015 and a slight decline in recent years, ultimately reaching 0.765 in 2022. This divergence suggests that improvements in human development are not uniform across the region and may be influenced by country-specific economic, institutional, and social factors.

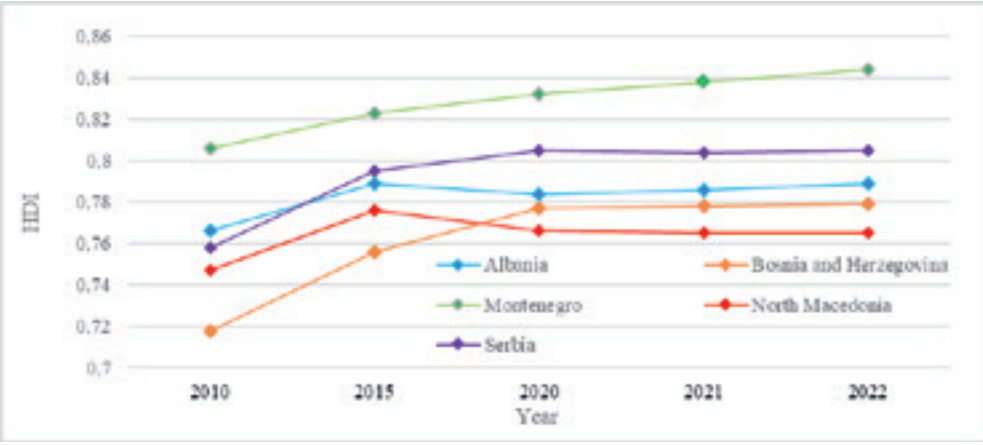

Figure 2. Trends in the Human Development Index (HDI) in Western Balkan countries, 2010–2022.
Source: Authors

Overall, the observed trends indicate gradual convergence in human development levels, yet persistent disparities remain. These findings underscore the importance of targeted policy interventions, particularly those aimed at reducing inequalities in health outcomes and strengthening inclusive economic growth, to sustain and accelerate human development across the Western Balkans.

Panel Regression Analysis

Table 3 reports the correlation matrix among the selected variables. Most correlation coefficients are below the threshold of 0.60, indicating relatively weak linear relationships among the explanatory variables and suggesting that multicollinearity is not a serious concern.

Table 3. Correlation matrix among HDI and selected socioeconomic indicators

Variable	HDI	GDP	LE	Gini	LEI
HDI	1				
GDP	0.6970***	1			
LE	0.1478	-0.3599	1		
Gini	-0.4951**	-0.4994**	0.2189	1	
LEI	-0.5132***	-0.7217***	0.3498	0.0657	1

Source: Authors; Note: ***p< .01; **p< .05

A strong, statistically significant positive correlation is observed between HDI and GDP per capita (r = 0.697, p< 0.01), suggesting that higher income levels are generally associated with greater human development. In contrast, the correlation between HDI and life expectancy is weak (r = 0.148), indicating a limited direct association between average longevity and HDI in the sample.

Table 4. Fixed-effects panel regression results for HDI

HDI	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval	Sig
GDP	5.81e-06	3.82e-06	1.52	.148	-2.30e-06	.0000139	
LE	.0052605	.0046882	1.12	.278	-.0046781	.0151991	
Gini	.000372	.0011309	0.33	.746	-.0020254	.0027696	
LEI	-.0100689	.0047459	-2.12	.050	-.0201297	-8.06e-06	**
Constant	.3905894	.3842916	1.02	.325	-.4240723	1.205251	
Mean dependent var	0.787		**SD dependent var**		0.030		
R-squared	0.614		**Number of obs**		25		
F-test	6.358		**Prob > F**		0.001		
Akaike crit. (AIC)	-153.066		**Bayesian crit. (BIC)**		-146.972		

Source: Authors; **Note:** **p < .05. Conventional model-based standard errors were used. Robust or country-clustered standard errors were not applied. Given the limited number of countries in the panel, statistical inference should be interpreted with caution.

The estimated fixed-effects regression equation is expressed as follows:

$$HDI_{it} = 0.3906 + 5.81 \times 10^{-6} GDP_{it} + 0.00526 LE_{it} + 0.00037 Gini_{it} - 0.01007 LEI_{it} + \varepsilon_{it} \quad (8)$$

Furthermore, HDI is negatively correlated with both income inequality (r = −0.495, p < 0.05) and inequality in life expectancy (r = −0.513, p< 0.01). These negative relationships suggest that higher levels of inequality—particularly in health outcomes—are associated with lower levels of human development.

The fixed-effects regression results presented in Table 4 demonstrate that the selected model explains a substantial proportion of the variation in HDI, as evidenced by an R-squared value of 0.614. The F-test is statistically significant at the 1% level (p = 0.001), which indicates that the explanatory variables are jointly associated with HDI in this model.

Analysis of individual coefficients reveals that inequality in life expectancy (LEI) exhibits a negative association with HDI, which is borderline statistically significant at the 5% level (p = .050). The confidence interval is close to zero, suggesting that this finding should be interpreted with caution. These results imply that greater disparities in survival outcomes may correspond to lower levels of human development in the selected Western Balkan countries. In contrast, GDP per capita, life expectancy at birth, and income inequality do not demonstrate statistically significant associations with HDI after accounting for country-specific effects.

The positive coefficient for GDP per capita indicates a positive association with HDI; however, this relationship is not statistically significant in the fixed-effects model.

Similarly, life expectancy at birth demonstrates a positive but statistically insignificant association with HDI. Income inequality also does not exhibit a statistically significant relationship with HDI in the regression analysis. Therefore, these findings should be interpreted as evidence of statistical associations rather than causal relationships.

DISCUSSION

A substantial body of literature links GDP per capita with the Human Development Index (HDI); however, relatively few studies base these relationships on panel-based empirical evidence. The results indicate that GDP per capita is positively and significantly correlated with the Human Development Index (HDI), suggesting that higher income levels are generally associated with greater human development. However, in the fixed-effects panel regression model, GDP per capita is not significantly associated with HDI. This outcome suggests that, within the selected sample and model specification, economic performance alone is not strongly associated with differences in human development after accounting for country-specific effects.

Inequality in life expectancy appears to be the most relevant statistical correlate of HDI in the selected model, although the evidence is borderline rather than unequivocally robust. The negative coefficient and p-value of .050 suggest a possible negative association between disparities in survival outcomes and human development. This result underscores the importance of health equity in understanding human development patterns in Western Balkan countries. Nevertheless, given the composite nature of HDI and potential endogeneity, this relationship should not be interpreted as causal.

As in other developing regions, GDP per capita in the Western Balkan countries has risen over the observed period. The results of this study indicate that GDP per capita is positively and significantly correlated with HDI, thereby partially confirming the hypothesis that higher income levels are associated with higher human development. However, when examined in a fixed-effects panel regression framework, GDP per capita does not show a statistically significant independent association with HDI, although it retains a positive coefficient.

This finding suggests that economic growth alone does not automatically translate into improvements in human development, even after controlling for country-specific characteristics. In this respect, the results are consistent with studies suggesting that economic growth may not have a direct or statistically significant association with HDI (Heriasman, 2020). Fluctuations in economic growth and the uneven distribution of income gains may limit the extent to which increases in GDP per capita improve broader living standards (Baseri & Farhadi Kia, 2008). Conversely, other studies report a statistically significant relationship between economic growth and HDI (Asmara et al., 2024), while research in Latin America indicates only a weak relationship between economic development and human development (Ranis et al., 2002). These mixed findings highlight the context-dependent nature of the growth–development nexus.

GDP per capita is often correlated with other components and associated factors of HDI, such as education and life expectancy, which may partially explain its lack of independent significance in multivariate models (Shah, 2016). When GDP per capita is held constant, inequality-related factors become more influential in shaping human development outcomes. This observation is particularly relevant for the Western Balkan countries, which exhibit relatively similar average GDP per capita levels but substan-

tial disparities in income distribution and health outcomes.

The results of this study show that income inequality and life expectancy inequality are negatively and significantly correlated with GDP per capita, suggesting that higher average income does not necessarily imply more equitable development. Countries with comparable income levels may still experience pronounced inequalities, which can offset the potential benefits of economic growth. This aligns with the broader literature, which emphasizes that economic growth without inclusiveness often disproportionately benefits higher-income groups, leading to persistent inequality and limited improvements in human development (Amponsah et al., 2023).

Regarding income inequality, the correlation analysis reveals a negative, statistically significant association with HDI. However, in the fixed-effects panel regression model, income inequality does not show a statistically significant independent association with HDI, despite a positive coefficient. These results provide partial support for the expected negative relationship between income inequality and HDI in the correlation analysis, but they do not support a statistically significant independent association in the fixed-effects regression model. It suggests that income inequality influences human development primarily through indirect channels, such as access to health care, education, and other social services. Unequal income distribution may therefore weaken the translation of economic growth into improvements in overall well-being.

The literature offers differing perspectives on the causal relationship between inequality and population health. Some scholars argue that the observed association is driven by the diminishing marginal returns of income on health at the individual level, rather than inequality itself (Deaton, 2003; Gravelle, 1998). Nevertheless, the findings of this study suggest the relevance of inequality in life expectancy as an associated factor in human development, although the regression evidence is borderline and should be interpreted with caution.

Inequality in life expectancy shows a negative correlation with HDI and a negative association in the fixed-effects regression model. However, the regression coefficient is borderline statistically significant ($p = .050$), and the confidence interval is very close to zero. Therefore, this finding should be interpreted cautiously. The estimated coefficient (−0.0100689) suggests that lower inequality in life expectancy may be associated with higher levels of human development, but the result should not be interpreted as a robust or causal effect. This finding provides cautious support for the expected negative relationship between life expectancy inequality and HDI and highlights the potential relevance of health equity in understanding human development patterns.

The causal impact of inequality on population health remains a subject of debate (Luo & Xie, 2020). Two dominant theoretical frameworks—the absolute income hypothesis and the contextual (Wilkinson) hypothesis—seek to explain the link between inequality and health outcomes. Recent research also emphasizes the importance of accounting for income mobility when assessing inequality in life expectancy (Kreiner et al., 2018). Despite ongoing debates, this study suggests that disparities in health outcomes may be relevant for understanding human development patterns in the Western Balkans.

Life expectancy at birth shows a positive but statistically insignificant correlation with HDI, and it is not statistically significantly associated with HDI in the fixed-ef-

fects regression model. Consequently, the hypothesis that life expectancy is positively and statistically significantly associated with HDI is not supported by the fixed-effects regression results. This finding suggests that improvements in average longevity alone are insufficient unless accompanied by reductions in health inequalities.

Socioeconomic factors such as health behaviors, access to healthcare, relative deprivation, and institutional trust vary across countries and over time, contributing to differences in life expectancy inequality. Identifying these factors is important for policymakers, particularly in developing regions where data limitations and measurement challenges persist. Evidence from countries with lower income inequality, such as the Nordic states and Spain, indicates that educational and socioeconomic disparities remain central drivers of life expectancy inequality (Silva-Illanes, 2024).

Finally, the HDI framework itself accounts for diminishing returns to income by incorporating the logarithm of income (Kurian, 2011). Empirical evidence from other contexts further illustrates that rising HDI does not always coincide with reductions in poverty or inequality (Nurjihan & Faizi, 2024; Walujadi, Indupurnahayu & Endri, 2022). Consistent with these findings, the results of this study support the argument that a more equitable distribution of health and income gains is important for sustainable human development.

STRENGTHS AND LIMITATIONS OF THE STUDY AND FUTURE STUDIES

The Human Development Index (HDI) is one of the most widely used composite indicators in development research. Despite its broad acceptance, the HDI has well-documented limitations, including a restricted set of indicators, potential weaknesses in indicator selection and weighting, methodological challenges, and trade-offs among its components (Sever, 2013). Nevertheless, the HDI remains a valuable analytical tool, as it captures the multidimensional nature of human development in a relatively comparable and accessible manner and continues to provide important insights into cross-country development patterns.

Another limitation involves potential conceptual overlap and endogeneity. Because the Human Development Index (HDI) directly includes life expectancy as its health dimension and income as its standard-of-living dimension, regressions that use HDI as the dependent variable and life expectancy or GDP per capita as explanatory variables may capture mechanical relationships rather than independent causal effects. Simultaneity may also arise, as higher human development can contribute to improved health outcomes and stronger economic performance. Therefore, the estimated coefficients should not be interpreted as causal effects. Future research should consider alternative model specifications, such as excluding variables that overlap with HDI components, analyzing changes in HDI, focusing on inequality-adjusted HDI or separate HDI dimension indices, or employing dynamic panel or instrumental-variable methods when appropriate data are available.

From a methodological perspective, empirical analyses based on HDI face several challenges. Multicollinearity may arise due to strong correlations among socioeconomic variables such as GDP, life expectancy, and education indicators, complicating coefficient interpretation. Moreover, while panel regression techniques are effective in controlling for unobserved heterogeneity and exploiting both cross-sectional and tem-

poral variation, they primarily identify associations rather than causal relationships. As a result, future studies could benefit from complementary econometric approaches, such as instrumental variable methods or dynamic panel models, to strengthen causal inference. Data quality and consistency also remain critical concerns, as variations in measurement and reporting across countries and time periods may affect the robustness of empirical findings.

The analysis is constrained by the limited number of country-year observations, which restricts the potential for additional robustness checks. With a short balanced panel comprising five countries across five selected years, incorporating further year-fixed effects, COVID-19 dummy variables, or alternative inequality indicators would significantly reduce degrees of freedom and could result in unstable estimates. The years 2020 and 2021 may nonetheless capture the impact of the COVID-19 shock on GDP, life expectancy, and human development outcomes. Furthermore, a comprehensive assessment of serial correlation and cross-sectional dependence was not feasible due to the small sample size. Future research utilizing longer annual panels should evaluate the robustness of these findings by including year fixed effects, omitting COVID-19 years, testing for serial correlation and cross-sectional dependence, and employing alternative measures of inequality.

Despite these limitations, the panel regression framework employed in this study represents a robust approach for analysing the relationship between economic, health-related, and inequality dimensions of human development. By accounting for country-specific effects and temporal dynamics, panel models enhance the reliability of estimated relationships and offer valuable policy-relevant insights.

Existing empirical evidence highlights the importance of education, human capital, and labour market factors in shaping HDI outcomes (Abdussamad et al., 2024; Teixeira & Queirós, 2016; Nurjihan & Faizi, 2024). Other studies emphasise the role of economic openness, technological development, and information and communication technologies (Faisal, 2022; Khan et al., 2019; Güz et al., 2025), as well as health, environmental, and resource-related factors (Dritsaki & Dritsaki, 2023; Ladi et al., 2021; Tian & Zhang, 2023). Incorporating these additional dimensions in future research would provide a more comprehensive understanding of human development dynamics.

CONCLUSION

This study provides empirical evidence on the statistical correlates of human development in the Western Balkan countries, with a particular focus on the role of inequality. The findings indicate that higher levels of income inequality and life expectancy inequality are associated with lower levels of human development, underscoring the detrimental effects of unequal distributions on overall development outcomes. Among the countries analysed, Montenegro records the highest HDI value in 2022, while both Montenegro and Serbia are classified in the very high human development category.

The fixed-effects panel regression results indicate that inequality in life expectancy is negatively associated with the Human Development Index (HDI) in the selected model. However, this association is only marginally statistically significant and should be interpreted with caution. This result suggests that disparities in survival

outcomes may be associated with differences in human development across Western Balkan countries. In contrast, GDP per capita, life expectancy at birth, and income inequality do not exhibit statistically significant associations with HDI within the fixed-effects specification. Due to the small sample size, conceptual overlap between HDI and certain explanatory variables, and potential endogeneity, these results should be regarded as statistical associations rather than evidence of causal relationships.

Overall, the results emphasize the need for a more inclusive and equitable approach to development in the Western Balkans—one that prioritizes reducing health and social disparities alongside economic growth. A more accurate reflection of human development must capture the lived experiences of all segments of society, particularly vulnerable and disadvantaged groups. Addressing inequalities in their various forms remains a central challenge for achieving sustainable and equitable human development, not only in the Western Balkans but globally.

LITERATURE

Abdussamad, S. N., Adityaningrum, A., & Payu, M. R. F. (2024). Panel Data Regression Analysis for Modeling the Human Development Index in North Sulawesi Province. Parameter: Journal of Statistics, 4(1), 46-53, https://doi.org/10.22487/27765660.2024.v4.i1.17138.

Akar, G., Saritas, T., & Kizilkaya, O. (2021). The impact of human development on economic growth: an application on transition economies. Business and Economics Research Journal, 12(2), 307-318. https://doi.org/10.20409/berj.2021.323_

Asmara, G. J., Asmara, G. D., & Saleh, R. (2024). The Effect of Economic Growth on The Human Development Index in Indonesia. Journal of Economics Research and Social Sciences, 8(2), 267–276. https://doi.org/10.18196/JERSS.V8I2.22627

Amponsah, M., Agbola, F. W., & Mahmood, A. (2023). The relationship between poverty, income inequality and inclusive growth in Sub-Saharan Africa. Economic Modelling, 126, 106415. https://doi.org/10.1016/J.ECONMOD.2023.106415

Baltagi, B. H. (2021). *Econometric analysis of panel data* (6th ed.). Wiley.

Baseri, B., & Farhadi Kia, A. (2008). The Analysis of Factors Affecting Human Development Index in Zanjan Province. Journal of Economic Research and Policies, 16(47), 5–23

Breusch, T., & Pagan, A. R. (1980). The Lagrange Multiplier Test and its Applications to Model Specification in Econometrics. The Review of Economic Studies, 47(1), 239. https://doi.org/10.2307/2297111

Campos-Vazquez, R. M., Chavez, E., & Esquivel, G. (2017). Growth is (really) good for the (really) rich. The World Economy, 40(12), 2639–2675. https://doi.org/10.1111/TWEC.12494

Castells-Quintana, D., Royuela, V., & Thiel, F. (2018). Inequality and sustainable development: Insights from an analysis of the human development index. *Sustainable Development, 27*(3), 448–460. https://doi.org/10.1002/sd.1917

Cheng, H., Luo, W., Si, S., Xin, H., Peng, Z., Zhou, Y., Liu, H., Yu, Y. (2022). Global trends in total fertility rate and its relation to national wealth, life expectancy and female education. *BMC Public Health* **22**, 1346. https://doi.org/10.1186/s12889-022-13656-1

Dahliah, D., & Nirwana Nur, A. (2021). The Influence of Unemployment, Human Development Index and Gross Domestic Product on Poverty level. Golden Ratio of Social Science and Education, 1(2), 95 - 108. https://doi.org/10.52970/grsse.v1i2.84

Deaton, A. (2003). Health, Inequality, and Economic Development. Journal of Economic Literature, 41(1), 113–158. https://doi.org/10.1257/002205103321544710

Deb, S. (2015, April). Gap between GDP and HDI: Are the rich country experiences different from

the poor. In IARIW-OECD special conference. http://old.iariw.org/papers/2015/deb.pdf

Dritsaki, M., & Dritsaki, C. (2023). The impact of GDP, human development, unemployment, and globalization on obesity. Asian Economic and Financial Review, 13(7), 431. https://doi.org/10.55493/5002.v13i7.4799

Faisal, S. (2022). Analysis of Human Development, Economic Growth and Income Inequality in SAARC Country. Journal of Development and Social Sciences. 3(2), 96-104, https://doi.org/10.47205/jdss.2022(3-II)10

Frey, B. S., & Stutzer, A. (2000). Happiness, *The Economic Journal, 110*(466), 918–938. https://doi.org/10.1111/1468-0297.00570

Ghifara, A. S., Iman, A. N., Wardhana, A. K., Rusgianto, S., & Ratnasari, R. T. (2022). The Effect of Economic Growth, Government Spending, and Human Development Index toward Inequality of Income Distribution in the Metropolitan Cities in Indonesia. Daengku: Journal of Humanities and Social Sciences Innovation, 2(4), 529-536. https://doi.org/10.35877/454RI.daengku1092

Girum, T., Muktar, E., & Shegaze, M. (2018). Determinants of life expectancy in low and medium human development index countries. Medical Studies/Studia Medyczne, 34(3), 218-225. https://doi.org/10.5114/ms.2018.78685

Gravelle, H. (1998). How much of the relation between population mortality and unequal distribution of income is a statistical artefact? BMJ, 316(7128), 382–385. https://doi.org/10.1136/BMJ.316.7128.382

Greene, W. H. (2018). *Econometric analysis* (8th ed.). Pearson.

Günay, E. K., & Topbaş, F. (2021). Impact of Income Distribution Inequality on the Human Development Index: Panel Data Analysis for BRICS Countries. Akademik Hassasiyetler, 8(17), 247-257.

Güz, T., Parim, C., & Çene, E. (2025). Examining the Impacts of GDP, Trade Openness, Freedom Index and the Internet on FDI: Comparison of Countries with Panel ARDL. Politická ekonomie, 2025(1), 88-124. https://doi.org/10.18267/j.polek.1445

Hausman, J. A. (1978). Specification tests in econometrics. *Econometrica, 46*(6), 1251–1271. https://doi.org/10.2307/1913827

Heriasman, H. (2020). The Effect Of Economic Growth And Capital Expenditure To Human Development Index (HDI) In Indragiri Hulu District. Jurnal Manajemen Dan Bisnis, 9(2), 208–217. https://doi.org/10.34006/JMBI.V9I2.158

Hsiao, C. (2014). *Analysis of panel data* (3rd ed.). Cambridge University Press.

Human Development Index (HDI) (2021). In: Leal Filho, W., Azul, A.M., Brandli, L., Lange Salvia, A., Wall, T. (eds) Industry, Innovation and Infrastructure. Encyclopedia of the UN Sustainable Development Goals. Springer, Cham. https://doi.org/10.1007/978-3-319-95873-6_300083

Human Development Index (HDI). (2025) Human Development Index (HDI), https://hdr.undp.org/data-center/human-development-index (Acess Date: 23.04.2025)

Hung, N. T. (2022). Effect of economic indicators, biomass energy on human development in China. Energy & Environment, 33(5), 829-852. https://doi.org/10.1177/0958305X211022040

Ianchovichina, E., & Lundstrom, S. (2009). Inclusive growth analytics : framework and application (Policy Research working paper; no. WPS 4851).

Islam, S. (1995). The human development index and per capita GDP. Applied Economics Letters, 2(5), 166–167. https://doi.org/10.1080/135048595357537

Jaumotte, F., Lall, S., & Papageorgiou, C. (2013). Rising income inequality: Technology, or trade and financial globalization? *IMF Econ Rev* **61**, 271–309. https://doi.org/10.1057/imfer.2013.7

Jauch, S. and Watzka, S. (2015). Financial development and income inequality: a panel data approach. Empirical Economics, 51(1), 291-314. https://doi.org/10.1007/s00181-015-1008-x

Khan, N. H., Ju, Y., & Hassan, S. T. (2019). Investigating the determinants of human development index in Pakistan: an empirical analysis. Environmental Science and Pollution Research, 26, 19294-19304. https://doi.org/10.1007/s11356-019-05271-2

Koh, S. G. M., Lee, G. H. Y., & Bomhoff, E. J. (2020). The income inequality, financial depth and economic growth nexus in China. The World Economy, 43(2), 412–427. https://doi.org/10.1111/TWEC.12825

Kreiner, C. T., Nielsen, T. H., & Serena, B. L. (2018). Role of income mobility for the measurement of inequality in life expectancy. Proceedings of the National Academy of Sciences of the United States of America, 115(46), 11754–11759. https://doi.org/10.1073/PNAS.1811455115/SUPPL_FILE/PNAS.1811455115.SD01.XLSX

Kurian, T. (2011). Human development index. In *The encyclopedia of political science* (p. 740). CQ Press. https://doi.org/10.4135/9781608712434

Ladi, T., Mahmoudpour, A., & Sharifi, A. (2021). Assessing impacts of the water poverty index components on the human development index in Iran. Habitat International, 113, 102375. https://doi.org/10.1016/j.habitatint.2021.102375

Lind, N. (2021). Objective inequality indexes joining income with life expectancy through the life quality index of sub-populations. Social Indicators Research, 153(3), 781-794. https://doi.org/10.1007/s11205-020-02504-7

Luo, W., & Xie, Y. (2020). Economic growth, income inequality and life expectancy in China. Social Science & Medicine, 256, 113046. https://doi.org/10.1016/J.SOCSCIMED.2020.113046

Mundlak, Y. (1978). On the Pooling of Time Series and Cross Section Data. Econometrica, 46(1), 69. https://doi.org/10.2307/1913646

Neumayer, E. (2001). The human development index and sustainability—A constructive proposal. *Ecological Economics, 39*(1), 101–114. https://doi.org/10.1016/S0921-8009(01)00201-4

Nurjihan, N., & Faizi, F. (2024). Examining The Influence Of Labor Force Participation And Islamic Human Development Index On Poverty: A Panel Data Regression Analysis. I-Economics: A Research Journal on Islamic Economics, 10(1), 25-41. https://doi.org/10.19109/ieconomics.v10i1.21763

Qiu, Q., Sung, J., Davis, W., & Tchernis, R. (2018). Using spatial factor analysis to measure human development. Journal of Development Economics, 132, 130-149. https://doi.org/10.1016/j.jdeveco.2017.12.007

Ranis, G., Luce, H. R., & Stewart, F. (2002). Economic growth and human development in Latin America. *CEPAL Review*, 2002(78), pp. 7–23. https://doi.org/10.18356/a7210436-en

Sasmita, N. R., Phonna, R. A., Fikri, M. K., Khairul, M., Apriliansyah, F., Idroes, G. M., & Saputra, F. E. (2024). Statistical assessment of human development index variations and their correlates: a case study of Aceh province, Indonesia. Grimsa Journal of Business and Economics Studies, 1(1), 12-24. https://journals.grimsa.org/gjbes/article/view/14/7

Schunck, R. (2013). *Within and between estimates in random-effects models: Advantages and drawbacks of correlated random effects and hybrid models.* **The Stata Journal, 13**(1), 65–76.

Sever, M. (2013). To what extent is the HDI a good indicator of the relative success or failure of national social policies? *Academic Journal of Interdisciplinary Studies, 2*(8), 208. https://www.richtmann.org/journal/index.php/ajis/article/view/723

Shah, S. (2016). Determinants of Human Development Index: A Cross-Country Empirical Analysis. International Journal of Economics and Management Studies, 3(5), 43–46. https://doi.org/10.14445/23939125/IJEMS-V3I5P106

Silva, M. E. A. d. (2020). Does inequality benefit growth? New evidence using a panel VAR approach. International Journal of Development Issues, 19(1), 63-76. https://doi.org/10.1108/ijdi-05-2019-0088

Silva-Illanes, N. (2024). Trends in socioeconomic inequalities in life expectancy and lifespan variation in Chile. Frontiers in Public Health, 12, 1404410. https://doi.org/10.3389/FPUBH.2024.1404410/BIBTEX

Singh, A. K., & Kumar, S. (2022). Exploring the impact of sustainable development on social-economic, and science and technological development in selected countries: A panel data analysis. Society & Sustainability, 4(1), 55-83. https://doi.org/10.38157/ss.v4i1.405

Taqi, M., e Ali, M. S., Parveen, S., Babar, M., & Khan, I. M. (2021). An analysis of Human Development Index and Economic Growth. A Case Study of Pakistan. iRASD Journal of Economics, 3(3), 261-271. https://doi.org/10.52131/joe.2021.0303.0042

Teixeira, A. A., & Queirós, A. S. (2016). Economic growth, human capital and structural change: A dynamic panel data analysis. Research policy, 45(8), 1636-1648. https://doi.org/10.1016/j.respol.2016.04.006

Tian, G., & Zhang, Z. (2023). Exploring the impact of natural Resource utilization on human capital development: A sustainable development perspective. Resources Policy, 87, 104207. https://doi.org/10.1016/j.resourpol.2023.10420

Triani, D., & Sitorus, A. (2023). The Influence of Human Development Index, Gini Ratio, Life Expectancy, and Economic Growth on Poverty in Aceh Province 2018-2022. In Proceedings of Bengkulu International Conference on Economics, Management, Business, and Accounting, Vol. 1, pp. 64-71.

United Nations Development Programme. (2024). *Human Development Reports: Documentation and downloads*. Human Development Report Office. Retrieved December 9, 2024, from https://hdr.undp.org/data-center/documentation-and-downloads

United Nations Statistics Division. (2024). *UNdata*. Retrieved December 9, 2024, from https://data.un.org/

Wooldridge, J. M. (2010). *Econometric analysis of cross section and panel data* (2nd ed.). MIT Press.

Walujadi, D., Indupurnahayu, I., & Endri, E. (2022). Determinants of income inequality among provinces: Panel data evidence from Indonesia. Calitatea, 23(190), 243-250.

WIR. (2019). World Inequality Report. Table 2.4.1. https://inequalitylab.world/en/. Accessed 03.02.2025.

WHO. (2025). World Health Organization. Data. http://apps.who.int/gho/data/view.main.61780?lang=en. Accessed 03.02.2025.

World Bank. (2022). *Poverity and Shared Prosperity 2022: Correcting Course*.

APPENDIX A

Table A1. Skewness and kurtosis tests of normality

Variable	Observations (Obs)	Pr(skewness)	Pr (kurtosis)	Adj chi2(2)	Prob>chi2
HDI	25	0.8483	0.6255	0.27	0.8716
GDP	25	0.2902	0.7594	1.31	0.5186
LE	25	0.8410	0.9916	0.04	0.9800
Gini	25	0.6133	0.6313	0.50	0.7773
LEI	25	0.3023	0.6321	1.40	0.4955

Source: Authors

Table A2. Variance inflation factor values

Variable	VIF	1/VIF
GDP	3.66	0.273552
LE	2.85	0.350609
Gini	1.79	0.558863
LEI	1.19	0.837822
Mean VIF	2.37	

Source: Authors

Table A3. White's test for heteroskedasticity

Test Statistic	chi2(14) = 16.65	Prob > chi2 = 0.2755
Null Hypothesis (H_0)	Homoskedasticity	
Alternative Hypothesis (H_1)	Unrestricted heteroskedasticity	

Source: Authors

Table A4. Cameron and Trivedi's information matrix (IM) test decomposition

Source	chi2	df	p-value
Heteroskedasticity	16.65	14	0.2755
Skewness	4.72	4	0.3172
Kurtosis	1.35	1	0.2461
Total	22.71	19	0.2502

Source: Authors

Table A5. Hausman specification test for fixed and random effects models

Variable	Fixed Coeff. (b)	Random Coeff. (B)	Difference (b-B)	sqrt(diag(V_b-V_B)) Std. Err. (s)
GDP	5.81e-06	8.38e-06	-2.58e-06	-
LE	0.0052605	0.012276	-0.0070155	0.0036155
Gini	0.0003721	-0.0025183	0.0028904	0.000343
LEI	-0.0100689	-0.007086	-0.0029829	0.002476

Source: Authors

b = Consistent under H_0 and H_a; obtained from xtreg.
B = Inconsistent under H_a, efficient under H_0; obtained from xtreg.
Test of H_0: Difference in coefficients not systematic
chi2(4) = (b-B)'[(V_b-V_B)^(-1)](b-B) = 248.09 ; Prob > chi2 = 0.0000