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Article

The nexus between economic, demographic, policy and human development in South Africa: An econometric analysis

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Abstract: The Human Development Index, which accounts for both net foreign income and the total value of goods and services generated domestically, illustrates how income becomes less significant as Gross National Income (GNI) rises by using the logarithm of income. South Africa ranks 109th out of 189 countries in the Human Development Index (HDI) within the Brazil, Russia, India, China and South Africa (BRICS) economic bloc, raising long-term sustainability concerns. The study explores the relationship between economic, demography, policy indicators and human development in South Africa. South Africa's unique status as a developing country within the BRICS economic group, alongside its lengthy history of racial discrimination, calls for a sophisticated approach to understanding Human Development. Existing research considered economic, demography, policy indicators independently; the gap of understanding their interconnection and long-term effects in the South African contexts exists. The study addresses the gap by using Autoregressive-Distributed Lag (ARDL) approach to investigate the short-term and the long-term relationship between economic, demography, policy indicators and human development in South Africa. By discovering these links, the study hopes to provide useful insights for policymakers seeking to promote sustainable human development in South Africa. The findings indicate that growth in GDP is a key factor in the HDI since it shows that there are more financial resources available for human development. By discovering these links, the study hopes to provide useful insights for policymakers seeking to promote sustainable human development in South Africa.

Keywords: economic; HDI; income; demography; policy indicators; BRICS economic bloc; South Africa; ARDL

1. Introduction

Many nations are trying to build up sustainable human development among them being South Africa. This is not only a matter of economic growth but also rather development of social conditions. Social justice is about equality of opportunity; that is, citizens have the right to a healthy life, quality education, and a dignified standard of living. South Africa, one of the five members of the Brazil, Russia, India, China and South Africa (BRICS) group of countries, faces specific challenges given its history and persistent racial inequalities. In this context, the Human Development Index (HDI) can be most appropriately described as a powerful instrument. The Human Development Index (HDI) is one of the most important instruments for assessing and contrasting the states of human development in various nations (Sagar and Najam, 1998). According to the United Nations Development Programmer (UNDP, 2021), South Africa's HDI has experienced a worrying decline. The HDI dropped from 0.727 in 2020 to 0.713 in 2021, representing a decrease of 0.014. Therefore,

industries including education, health, manufacturing, and mining are negatively impacted by a decline in human development.

The United Nations Development Programmer has evaluated these elements every year since 1990 by publishing the HDI. In 2021, Switzerland held the top spot with an HDI of 0.965 (life expectancy: 73.0 years, expect schooling years: 16.6 years & GNI: $68,550), followed by Hong Kong HDI being 0.959 (85.5 years, 17.7 years & $64,151) and Iceland being 0.957 (82.7 years, 19.1 years & $52,671). Within Africa, Seychelles leads the continent with 0.795 (71.3 years, 13.3 years & $25,876); Mauritius 0.790 (73.6 years, 14.6 years & $21,199) and Egypt 0.726 (70.2 years, 12.9 years & $11,827) follow closely behind. Conversely, Niger and Chad face significant challenges, reflected in their low HDI scoring (0.389 & 0.393 respectively), life expectancy (61.6 years & 52.5 years); Expected schooling years (7.2 years & 8.2 years) and GNI ($1.209 & $1.405).

Additionally, the report claimed that the BRICS nations—Brazil, Russia, and China—had made notable advancements in human development. Russia, for example, scored 0.818 on the HDI, (69.4 years, 15.7 years & $27,480); China, with a HDI score of 0.785 (78.2 years, 15.2 years & $17,499) and Brazil, meanwhile, scored 0.756, (72.8 years, 15.6 years & $14,342). India and South Africa made some headway, they are still far behind; India scored 0.633 (67.2 years, 12.0 years & $6542) and South Africa scored 0.717 (61.5 years, 14.3 years & $13,186). South Africa's decline of −0.004 in HDI necessitates a closer look at the underlying factors. Understanding the reasons behind this decline is crucial for formulating effective policies aimed at improving human development outcomes in South Africa.

Furthermore, HDI is divided into three dimensions: life expectancy (health), literacy (education), and standard of living (Dasic et al., 2020). Since literacy (education) increases people's power, develops their skills, and promotes socioeconomic advancement, it is a crucial component in defining human progress. It has been discovered that educational investments improve the HDI in terms of both quality and accessibility. There have been a number of issues with South Africa's education system, such as low levels of support and training for teachers, limited funding, and subpar facilities. The three components of South Africa's educational system are basic school, further education and training, and higher education, according to Govender (2017). While private institutions and the government finance the other two, the government is in charge of funding and supervising the basic education sector. Over the past 20 years, South Africa's education spending has expanded dramatically, rising from 5.8% of GDP in 2000 to 6.9% in 2018 (Dessus and Hanusch, 2018).

This increase in investment will have a significant effect on South Africa's human development and likely signal an improvement in the country's overall level of human development.

As a result of the fact that factors including general wellness, disease prevention, and access to healthcare have a substantial impact on human development outcomes, Bayati et al. (2013) claim that life expectancy (health) is another important element determining the HDI. According to Bates et al. (2015), South Africa has a remarkably high disease burden of both communicable and non-communicable diseases, including diabetes, TB, and HIV/AIDS. Improving people's quality of life

and fostering human growth require access to high-quality healthcare. Nonetheless, there are notable disparities in the nation's healthcare system, especially for those who reside in rural and impoverished areas.

With a score of 0.713 and a gross national income of $12,948, South Africa is ranked 109th out of 189 countries in the Human Development Index (HDI) published by the United Nations Development Programmer. Stjepanović et al. (2017) state that gross national income per capita, which is used to assess a nation's economic health, is a good indicator of the level of life. Furthermore, the HDI, which accounts for both net foreign income and the total value of goods and services generated domestically, illustrates how income becomes less significant as GNI rises by using the logarithm of income. While studies have been done on human development and the economic, demographic, and policy framework to clarify their influence on South Africa's HDI, there hasn't been much research done on the long- and short-term links between the variables. By examining these interconnected variables, research hope to uncover places where focused interventions could promote long-term human development. To close the gap, this study looks at the following research questions: i) In what way do economic factors like GDP growth affect human development results in South Africa? ii) How do demographic transitions mix with policy choices to influence human development in South Africa? With this goal in mind, the study uses the ARDL method to investigate the short- and long-term correlations between these factors and South Africa's Human Development Index (HDI). The paper is structured as follows Introduction, theoretical framework, literature review, data and methods, summary Conclusions and Recommendations.

Theoretical framework: Post-development theory

In the 1980s and 1990s, disillusioned with the failures of conventional development strategies to combat poverty and promote human well-being in many developing nations, scholars such as Arturo Escobar, Gustavo Esteva, Majid Rahnema, Wolfgang Sachs, James Ferguson, Serge Latouche, Gilbert Rist, and Filippo Sabelli, spearheaded the critical approach known as post-development theory. The theory emerged and challenged the idea of "development" as a monolithic Western imposition (Escobar, 1995). The premise that all civilizations must progress linearly toward modernization in the manner of the West led post-development scholars to contend that these models were inherently Eurocentric (Sachs, 1992). They criticized this strategy for being both unachievable and harmful, pointing to the deterioration of traditional traditions as well as the exploitation of people and resources in the Global South (Escobar, 1995). Post-development theory, on the other hand, supports a multidimensional strategy that places an emphasis on individual choice, ecological sustainability, and human well-being above only economic modernization and progress. Its basic tenet is that local communities' needs and goals should inform development, with consideration for the many cultures and beliefs of the community (Rahnema, 1992).

This viewpoint diverges from the conventional interpretation of development as being exclusively concerned with economic growth. Rather, it highlights the

significance of more expansive aspects of human flourishing, such as social justice, health, and education (Matthews, 2010). This broader perspective is reflected in the Human Development Index (HDI), a composite statistic that considers these three important factors. Moreover, the active involvement of local populations in development activities is promoted by post-development theory. This is a result of the realization that development is about empowering people and making their lives better, not just about economic prosperity. People have a stronger sense of ownership and dedication when they are able to direct their own growth, which may result in more significant outcomes (Matthews 2010). Ultimately, long-term sustainability plays a crucial role, as highlighted by post-development theory. This means making sure that development strategies satisfy current needs without jeopardizing the ability of future generations to satisfy their own. Maintaining human progress requires a focus on sustainability, which ensures that resources are distributed fairly so that present and future generations can live happy, full lives. According to post-development theory, nations with high Human Development Indexes (HDI) are more dedicated to human development and make more investments in social programs, health care, and education. On the other hand, issues including poverty, inequality, access to healthcare and education, and environmental degradation are present in nations with low HDI scores. The idea, which contends that globalization and colonialism have contributed to underdevelopment, can assist governments in recognizing and resolving these problems. Resolving structural inequalities is essential to human development. By emphasizing the demands of the local population and promoting ecologically responsible growth, post-development theory might assist nations in creating more equitable and sustainable development strategies. In general, post-development theory provides an invaluable framework for comprehending the opportunities and problems associated with human progress, paving the way for effective policies and initiatives that enhance people's lives and well-being.

2. Literature review

Indian economist Amartya Sen followed Pakistani economist Mahbub-ul-Haq in creating and introducing it in 1990. The Human Development Index, or HDI, is a comprehensive index that the United Nations created to assess and gauge the social and economic development of different nations. It contrasts life expectancy, literacy, education, and living standards (Shah, 2016). The Human Development Index (HDI) offers a thorough evaluation of a country's progress, focusing on aspects such as health and education and emphasizing the welfare of its citizens. It makes international comparisons possible and aids in pinpointing issues that need to be resolved in order to improve living standards overall. Pinar et al. (2013) considered a stochastic dominance approach for measured human development such as the official equally weighted HDI, and they compared the official equally weighted HDI to all possible indices constructed from a set of individual components to achieve the most optimistic scenario for development. Their findings revealed that the official, equally weighted HDI may not accurately capture the true level of human development. By considering alternative indices constructed from individual components, they were

able to identify potential areas for improvement and provide a more comprehensive assessment of development. Using this method, they were able to identify advancement dimensions that the official HDI had failed to adequately capture. The alternative indices also allowed governments to prioritize targeted interventions for improvement by giving them a more detailed understanding of the positives and negatives associated with various facets of human development.

Building on this point in a global perspective Economists such as Khan (2015) have—traditionally viewed education as a key engine for the economic growth. Nevertheless, this relationship is not a one-way traffic. Chiappero-Martinetti (2015) highlights the two-way relationship where not only the growth of economy can help to bring better human development outamped through investment in education and healthcare. Daniela-Mihaela (2015) points out the importance of investing in the human capital because of its crucial role in the economic and social development process (Luetz and Walid, 2019). For instance, introduces a critical point, possibly one that may be pushing the limits in the views of economists on international development. They lobby for the comprehensive approach, which provides a trio of economic aims, environmental sustainability features and with social considerations. These combined perceptions put forward the notion of looking at the economy and human development as isolated notions but rather as interlinked fundamental elements to be tackled comprehensively and balancing between the two.

Several variables add to the Human Development Index (HDI) in BRICS countries. Economists like Rastogi and Gaikwad (2017), and Türkmen and Ağır (2022) have emphasized the positive influence of economic factors such as a strong Gross Domestic Product (GDP) and Foreign Direct Investment (FDI) on a nation's HDI. Additionally, Kuriy (2015) highlights the importance of fostering human potential development to drive economic growth, with countries like China and India demonstrating success in this area. However, Kuriy's (2015) study also underscores the need to focus on institutional development, social and economic infrastructure, and reforms in Brazil, Russia, and South Africa. These combined findings suggest that a multi-faceted approach considering both economic and human development factors, including GDP, FDI, and human potential development, is key to achieving a high HDI in BRICS countries.

Understanding the variables affecting human development in South Africa is not a simple task. Economist like Thorbecke (2013) stated that each nation should have its specific development strategies depending on its particularities. The historical context, endowment of resource and the standard of living all have influence on the most appropriate strategy. Demographic composition is another important factor. Osei-Appaw and Christian (2022) discussed a "demographic dividend" with a combined population growth rate and education level improvement. At the same time, the developmental effects (e.g., employment opportunities) can be maximized. However, blindly following the textbook economical models is not a solution. The slow pace in which South Africa attains human development and technology suggests that policies that give both a boost would be appropriate.

Several recent studies have considered the determinants of the Human Development Index (HDI). Acar and Topdağ (2022), on the other hand, investigated a cross-sectional analysis of factors affecting human development index. The researchers ran

different quantile regression technique on a cross-sectional analysis. Their findings provide evidence of the fact that per capita income, democracy, urbanization, and IFIs (institution for financial compensation) cause positive changes in HDI. On the contrary, childhood mortality rates of infant were revealed to contribute to hamper human development. These studies demonstrate the complex nature of indicators of HDI, reflecting both economic (poverty, unemployment, inflation, income) and political (democracy) factors, urbanization and even the impact of international finance (IMF loans).

Tsaurai (2018) was looking for factors that contribute to market compensation implementation, using different techniques such as pooled OLS, fixed and random effects. Their results indicate economic progress, FDI, financial development, openness to the international trade environment, and infrastructure construction positively affect economic growth. However, Shuaibu and Oladayo (2016) established institutions to be the only element with a noticeable short-term effect on HCD. These studies, therefore, demonstrate that undertaking policies, which focus on the development of the economy, attracting the foreign direct investment (FDI), building the financial system, encouraging trade and strengthening the infrastructure in the long term, can result in improving the human capital. Finally, strong institutions are important for both the short-term and the long-term aspects of human capital development.

Fadillah and Setiartiti (2021) researched "Analysis of Human Development Index Factors 2008–2014 (Case Study of the District/City of DI Yogyakarta)". The variables utilized were per capita income, government spending on the healthcare sector, government spending on public infrastructure, the Gini coefficient, the number of poor individuals, and the HDI. The Random Effect Model is employed. The findings of this study reveal that the per capita income variable has no effect on HDI. Then, government spending on health has a major impact on HDI. Following that, government spending on public infrastructure has a favorable connection with HDI. Finally, the Gini coefficient has a significant negative association with HDI, as does the proportion of the poor. However, Astuti (2018) researched "Analysis of Factors Affecting the Human Development Index in the Special Regional of Yogyakarta 2010–2016". Human Development Index, Economic Growth, Poverty, Education, and the Gini Index are the variables examined. The panel data was used with the fixed effect model's approach. According to the findings of this study, the variables of economic growth and education had a substantial effect on HDI. The Gini variable, on the other hand, had a significant as well as negative impact on the Human Development Index, whereas poverty had no significant effect on the Human Development Index.

Furthermore, Hafner and Mayer-Foulkes (2013) examine fertility, economic growth, and human development as causal factors of the developed lifestyle. The study employed dynamic OLS estimation approaches to estimate the long-run relationship among cointegrated variables. Fertility has a negative relationship to human development but is favorable to income as well as trade. Furthermore, neither developed countries nor developing economies indicate a major impact of human development on income.

3. Data and method

The Data and Methods section will present the rationale for employing different models. According to the reviewed research, the Human Development Index (HDI) is determined by a complex interaction of variables. The indicators like Economic factor; unemployment, inflation and foreign direct investment have been revealed to control HDI (Tsaurai, 2018). Furthermore, demographic factors such as population density, democracy, and urbanization and childhood mortality rates of infant are very important determinants (Kuriy, 2015; Osei-Appaw and Christian, 2022). Finally, in a way, policy frameworks are related to meanwhile policy framework revealed openness to the international trade environment, and infrastructure construction and social safety nets, which reflect on a lot in the quality of life. (Tsaurai, 2018). This multi-model approach provides multiple advantages. By paying attention to specific categories, all models can delve deeper into unique connections between the variables and HDI. This enables a more exact comprehension of how economic conditions, demographics, and policy decisions all influence South Africa's human development.

3.1. Model specification

The model's parameters are based on empirical research on various factors that impact human development among jurisdictions, and no logarithmic transformations have been performed to the variables. In this case, the model's specifications are comparable to those of studies Sana et al. (2020) that look at the long- and short-term relationships between trade aid and human development, but they have been modified to fit the South African context. This is to verify that the model provided is in good agreement with other comparable studies carried out in various jurisdictions. The Econometric Models are specified as follows:

1) Economic Indicators.

$$HDI_t = f\,(GDP_t, UNE_t, FDI_t, CPI_t) \quad (1)$$

where HDI is Human development index of the country at period *t*, which is the function of GDP is the Gross Domestic Products of the country at period *t*, CPI is the Inflation of the country at period *t*, UNE is the Unemployment of the country at period *t*, FDI is the Foreign Direct Investment of the country at period *t*.

2) Demographic Indicators.

$$HDI_t = f\,(POP_t, FR_t, GI_t) \quad (2)$$

where HDI is Human development index of the country at period *t*, which is the function of POP is the Population of the country at period *t*, GI is the Gini Index of the country at period *t*, FR is the Fertility Rate of the country at period *t*.

3) Policy Framework.

$$HDI_t = f\,(ICT_t, TRA_t) \quad (3)$$

where HDI is Human development index of the country at period *t*, which is the function of; ICT is the Information and Communication Technology of the country at period *t*, TRA is the Trade of the country at period *t*.

The Mathematical form of the model is as follows:

4) Economic Indicators.

$$HDI_t = \beta_0 + \beta_1 GDP_t + \beta_2 UNE_t + \beta_3 FDI_t + \beta_4 CPI_t + \varepsilon_t \quad (4)$$

where all other variables are as defined previously, expect beta β_0 which represents the constant, β_{1-4} are the coefficients and ε_t is the error term.

5) Demographic Indicators.

$$HDI_t = \beta_0 + \beta_1 FR_t + \beta_2 POP_t + \beta_3 GI_t + \varepsilon_t \quad (5)$$

where all other variables are as defined previously, expect beta β_0 which represents the constant, β_{1-3} are the coefficients and ε_t is the error term.

6) Policy Framework.

$$HDI_t = \beta_0 + \beta_1 ICT_t + \beta_2 TRA_t + \varepsilon_t \quad (6)$$

where all other variables are as defined previously, expect beta β_0 which represents the constant, β_{1-2} are the coefficients and ε_t is the error term.

The suitability of using a trade variable for policy framework estimation over an economic framework estimation is based on the specific context, objectives, and scope of our analysis. Trade variables are directly significant for policy development and evaluation because policymakers frequently emphasize trade-related objectives, such as encouraging exports, lowering trade deficits, or enhancing trade competitiveness. According to McNab and Moore (1998) trade plays an important role in shaping policies and can contribute to human capital. This human capital creates conditions that are favorable for improvements in human development. Also, Mustafa et al. (2017) emphasize that economic growth may not be adequate to boost human development in developing countries. However, Trade liberalization policies, which are Policy framework, are likely to be viewed as critical for attaining long-term human capital, which leads to improved human development index.

3.2. Data sources

To examine the relationship between the factors that determine the Human Development Index, time series data covering the years 1990 through 2021 are gathered. The study makes use of the data sample size of 31 and the annual secondary data. The World Bank, SARB, Macrotrends, SWIID, and UNDP Data Center provided the data for this study. E-views software was utilized to analyze the data. The following variables will be used in this study: Demographic Indicators (Population Rate, Gini Index, and Fertility Rate), Policy Framework (Information Communication and Technology and Trade), and Economic Indicators (Human Development Index, Consumer Price Index, Unemployment, Gross Domestic Products, and Foreign Direct Investment). **Table 1** below shows the summary of the variables used in the analysis.

3.3. Variables definition and expected signs

Table 1. Summary of variables definition and expected signs for economic indicators/demographic indicators/policy framework.

S/N	Variables	Proxy	Variables definition	Measures	Expected signs	Source
1	Human Development	HDI_t	HDI is a composite statistic that evaluates countries based on their average achievements in the three primary categories of human development: life expectancy (health), education, and standard of living (income)	Overall wellbeing	Dependent	UNDP Data Centre
2	Consumer Price index (Inflation)	CPI_t	Consumer Price Index (CPI) monitors the average change in prices spent by urban consumers for a basket of consumer goods and services	Changes in Prices over time	− Negative	Macro trends
3	Unemployment rate	UNE_t	The labour force is the total number of persons who are employed or actively looking for work	The number of people actively looking for a job as a percentage of the labour force	− Negative	Macro trends
4	Gross Domestic Products	GDP_t	Gross domestic product is the total financial value of all final goods and services produced inside a country over a specified time period, usually a quarter or a year.	Economic activities, does not measure the standard of living	+ Positive	SARB
5	Foreign Direct Investment	FDI_t	Foreign Direct Investment is an investment made in one country by a firm or individual in assets or a business in another	Total level of direct investment	+ Positive	Macro trends
6	Population Rate	POP_t	The population rate measures how quickly a population expands or declines.	Population size and population density	− Negative	World Bank
7	Gini Index	GI_t	The Gini Index is a statistical dispersion indicator used to quantify income, wealth, or consumption inequality within a nation or social group.	Distribution of income or wealth within a country	− Negative	Standardized World Income Inequality Database
8	Fertility Rate	FE_t	The fertility rate is a measure of the average number of children born to a woman in her lifetime	Average number of children that would be born to a woman	+ Positive	World Bank
9	Information and Communication Technology	ICT_t	ICT is referred to the convergence of computing, telecommunications, as well as digital technologies that enable the generation, processing, transmission, and storage of information	A wide range of technologies	+ Positive	World Bank
10	Trade	TRA_t	Trade referred to as the voluntary exchange of products and services between individuals, businesses, or countries	Annual Growth of trade	+ Positive	World Bank

Source: Authors computation.

3.4. Econometric estimations

3.4.1. Unit root and stationarity test

A stationarity (or non-stationarity) test that has gained prominence recently is the unit root test (Gujarati, 2004). A statistical method called the Unit Root Test is used to determine whether a unit root exists in time series data. A time series data characteristic that indicates a high degree of persistence or dependence on prior values is called a unit root (Phillip and Perron, 1988). Furthermore, the existence of a unit root in time series data can lead to erroneous assumptions and skewed estimates. Therefore, it is essential to determine whether a unit root exists in time series data

before using any estimating methods. Unit root tests include the Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test, the Phillips-Perron (PP) test, and the Augmented Dickey-Fuller (ADF) test. The order autoregressive model for unit root testing is represented by the equation below (Gujarati, 2004).

$$Y_t = \rho Y_{t-1} + \mu_t$$
$$-1 \leq \rho \leq 1 \tag{7}$$

where u_t is a word for white noise error.

We know that if $\rho = 1$, then the unit root in Equation (1) becomes a random walk model with no drift, which is a nonstationary stochastic process. Equation (1) is manipulated as follows for theoretical reasons: Subtract Y_{t-1} from both sides of Equation (1) to get.

$$Y_t - Y_{t-1} = \rho Y_{t-1} + \mu_t$$
$$(\rho - 1)\, Y_{t-1} + \mu \tag{8}$$

which can be alternatively written as:

$$\Delta Y_t = \delta Y_{t-1} + \mu_t \tag{9}$$

where $\delta = (\rho - 1)$ and Δ, as is common, is the first-difference operator.

If $\delta = 0$, then $\rho = 1$, indicating that we have a unit root, indicating that the time series under discussion is nonstationary. The unit root test is an important step in time series analysis because it helps to verify the reliability of any estimate technique's results. The ADF test is one of the most often used unit root tests, however depending on the nature of the data and research issue, researchers may choose to employ other tests (Gujarati, 2004).

The Augmented Dickey-Fuller (ADF) test is a common statistical technique to identify the existence of a unit root in a time series dataset. The presence of a unit root shows that the time series is nonstationary, which might have consequences for model construction and forecasting, (Chang and Park, 2002). They further stated that the ADF test is an extension of the Dickey-Fuller test, which is a simplified version of the test that does not take certain statistical factors into account that can affect the results. The ADF test was conducted by regressing the time series' first difference on the lagged values and additional lagged differences. The null hypothesis of the ADF test is that the time series has a unit root, whereas the alternative hypothesis is that the time series is stationary (Chang and Park, 2002). The ADF test generates a *t*-statistic, which is used to assess whether to reject the null hypothesis.

$$\Delta Y = \beta_t + \beta_{2t} + \delta Y_{t-1} + \sum^{m}_{t=1} \gamma \Delta Y_{t-1} + \varepsilon_t \tag{10}$$

The ADF test here consists of estimating the following regression:

Where ε_t is a pure white noise error term and where $\Delta Y = (Y_{t-1} - Y_{t-2})$, $Y_{t-2} = (Y_{t-2} - Y_{t-3})$, etc. The number of lagged difference terms to include is often determined empirically, the idea being to include enough terms so that the error term in Equation (4) is serially uncorrelated. In ADF, we still test whether $\delta = 0$ and the ADF test follows the same asymptotic distribution as the DF statistic, so the same critical values can be used. (Gujarati, 2004)

According to the literature, ADF unit root tests have low size properties

(Maddala and Kim, 1999). Most of the research utilized more than one unit root test to check whether they could yield the same result. However, the study acknowledges that depending entirely on the ADF test may be considered an obstacle. The study considered ADF solely as it is one of the most widely employed unit root tests in econometrics. Moreover, future study in this topic may benefit from using a variety of unit root tests to improve the robustness of findings.

3.4.2. ARDL bounds test

In terms of methodology, the study adopts the ARDL approach for investigating the determinants of the Human Development Index. According to Duasa (2007), the ARDL framework was developed by Pesaran and Shin (1995, 1999) and Pesaran et al. (1996). There are several advantages of utilizing this technique instead of the traditional Johansen (1998) and Johansen and Juselius (1990) techniques. The key advantage of the ARDL model in terms of long-run relationship power and testing is that it may be carried out regardless of the order of integration, a combination of (0) and I (1) variables as regressors which indicates that the order of integration of suitable variables may not be the same (Verma, 2007). Another advantage is that the technique is appropriate for small or finite sample sizes whereas other Cointegration strategies require all variables to be of the same level of integration (and in big samples). Moreover, the ARDL allows various variables to have different optimal lags, which the usual Cointegration test does not allow for (Ali et al., 2017). The existence of Cointegration implies that both long run as well as short-run coefficients can be determined via an unrestricted error correction model (UECM). To build an ARDL bounds Cointegration model this study expresses the equation as follows:

1) Economic Indicators.

$$\Delta HDI_t = \alpha_0 + \sum^{p}_{i=1} \alpha_{1i} \Delta HDI_{t-1} + \sum^{p}_{i=1} \alpha_{2i} \Delta FR_{t-1} + \sum^{p}_{i=1} \alpha_{3i} \Delta POP_{t-1} + \sum^{p}_{i=1} \alpha_{4i} \Delta GI_{t-1} + \varphi\ ECM_{t-1} + \mu_t \quad (11)$$

where all other variables are as defined previously, expect; Δ which is the difference operator, α_0 is the constant, α_{1-5} are the respective long-run coefficients and β_{1-5} are estimated short-run coefficients, μ_t is the error term.

2) Demographic Indicators.

$$\Delta HDI_t = \alpha_0 + \sum^{p}_{i=1} \alpha_{1i} \Delta HDI_{t-1} + \sum^{p}_{i=1} \alpha_{2i} \Delta TRA_{t-1} + \sum^{p}_{i=1} \alpha_{3i} \Delta ICT_{t-1} + \varphi\ ECM_{t-1} + \mu_t \quad (12)$$

where all other variables are as defined previously, expect; Δ which is the difference operator, α_0 is the constant, α_{1-4} are the respective long-run coefficients and β_{1-4} are estimated short-run coefficients, μ_t is the error term.

3) Policy Framework.

$$\Delta HDI_t = \alpha_0 + \alpha_1 HDI_{t-1} + \alpha_2 TRA_{t-1} + \alpha_3 ICT_{t-1} + \sum \beta_{1i}\ HDI_{t-1} + \sum \beta_{2i}\ TRA_{t-1} + \sum \beta_{3i}\ ICT_{t-1} + \varepsilon_t \quad (13)$$

where all other variables are as defined previously, expect; Δ which is the difference operator, α_0 is the constant, α_{1-3} are the respective long-run coefficients and β_{1-3} are estimated short-run coefficients, μ_t is the error term. According to Tlharipe-Mothibi (2020), the ARDL bounds test is based on the Wald-test, which is the *F*-statistic. To determine Cointegration, the *F*-test statistic is assessed against the two critical boundaries, which are the lower and upper bounds. Therefore, the null hypothesis of no Cointegration can be rejected if the result estimated exceeds the upper critical restriction.

3.4.3. Estimating short-run Coefficients

After conducting the Cointegration test and discovering its presence, it recommends estimating an error correction model (ECM). This assists in determining the rate at which the variables adapt to their long-run equilibrium value (Gujarati and Porter, 2009). The error correction model can be represented in ARDL as follows:

1) Economic Indicators.

$$\Delta HDI_t = \alpha_0 + \sum^{p}_{i=1} \alpha_{1i} \Delta HDI_{t-1} + \sum^{p}_{i=1} \alpha_{2i} \Delta CPI_{t-1} + \sum^{p}_{i=1} \alpha_{3i} \Delta UNE_{t-1} + \sum^{p}_{i=1} \alpha_{4i} \Delta FDI_{t-1} + \sum^{p}_{i=1} \alpha_{5i} \Delta GDP_{t-1} + \varphi ECM_{t-1} + \mu_t \quad (14)$$

where all variables are as defined with the exception of ECM_{t-1}, which is the Error Correction Term. *ECM* is a residual from the estimated Cointegration Equation (14), and φ is a parameter that indicates the long-run adjustment speed. Ideally, the *ECM* coefficient should be negative, statistically significant, and less than unity.

2) Demographic Indicators.

$$\Delta HDI_t = \alpha_0 + \sum^{p}_{i=1} \alpha_{1i} \Delta HDI_{t-1} + \sum^{p}_{i=1} \alpha_{2i} \Delta FR_{t-1} + \sum^{p}_{i=1} \alpha_{3i} \Delta POP_{t-1} + \sum^{p}_{i=1} \alpha_{4i} \Delta GI_{t-1} + \varphi ECM_{t-1} + \mu_t \quad (15)$$

where all variables are as defined with the exception of ECM_{t-1}, which is the Error Correction Term. ECM is a residual from the estimated Cointegration Equation (15), and φ is a parameter that indicates the long-run adjustment speed. Ideally, the ECM coefficient should be negative, statistically significant, and less than unity.

3) Policy Framework.

$$\Delta HDI_t = \alpha_0 + \sum^{p}_{i=1} \alpha_{1i} \Delta HDI_{t-1} + \sum^{p}_{i=1} \alpha_{2i} \Delta TRA_{t-1} + \sum^{p}_{i=1} \alpha_{3i} \Delta ICT_{t-1} + \varphi ECM_{t-1} + \mu_t \quad (16)$$

where all variables are as defined with the exception of ECM_{t-1}, which is the Error Correction Term. ECM is a residual from the estimated Cointegration Equation (16), and φ is a parameter that indicates the long-run adjustment speed. Ideally, the ECM coefficient should be negative, statistically significant, and less than unity.

3.4.4. Diagnostic tests

The below classical assumptions ensure that results produced are robust and validated

1) Serial correlation

According to Gujarati and Porter (2009), serial correlation refers to the degree of interaction between residuals or errors across different periods in statistical models. It is critical in econometrics and time-series analysis to examine residual data for signs of serial correlation, as this violates fundamental independence assumptions needed for efficient parameter estimation and proper hypothesis testing. The LM test for serial correlation is a common method to detect serial correlation for regression model residuals. When there is no serial correlation, the test assumes that residuals have a strong correlation with their lagged values.

2) Heteroskedasticity

Heteroskedasticity is a statistical phenomenon where the error terms in a regression model's variance is not constant across all independent variables. This means that the spread or dispersion of residuals may differ for different predictor values. Violation of the assumption of homoscedasticity (constant variance) can lead to biased and inefficient estimates of regression coefficients, affecting the validity of

statistical inference. According to Greene (2008), heteroskedasticity occurs when the variance of error terms in a regression model is no longer constant across all levels of independent variables, resulting in the spread or dispersion of residuals differing from the predictor value.

The Heteroskedasticity equation is as follows:

$$E\ (\mu^2_i) = \sigma^2_i \tag{17}$$

3) Normality test

A normality test is a statistical method for determining if a dataset follows a normal distribution, often known as the Gaussian distribution or the bell curve. The Jarque-Bera (JB) Test of Normality is an asymptotic, large-sample test that uses OLS residuals. This test computes the skewness and kurtosis of the OLS residuals first and then employs the following test statistic:

$$\text{JB} = n\ [(s^2/6) + (k - 3)^2/24] \tag{18}$$

where n = sample size, S = skewness coefficient, and K = Kurtosis coefficient. $S = 0$ and $K = 3$ for a normally distributed variable. Therefore, the *JB* normality test is a test of combined hypothesis that S as well as K are 0 and 3, respectively. In that case, the *JB* statistics will be expected to be equal to 0 (Gujarati, 2004).

4) Multicollinearity

Multicollinearity is a statistical phenomenon in regression analysis where two or more predictor variables have high correlation, leading to unstable parameter estimates and inflated standard errors. It challenges the concept of predictor variable independence, which is crucial for accurate regression analysis (Gujarati, 2004). Techniques for detecting multicollinearity include correlation coefficient, variance inflation factor, and eigenvalue method (Belsley et al., 1980).

VIF is calculated as:

$$\text{VIF}= (1/1 - R^2) = (1/\text{Tolerance}) \tag{19}$$

where, Tolerance is the inverse of VIF. If the tolerance is lower, therefore it is more likely that there is multicollinearity between the variables.

3.4.5. Stability testing

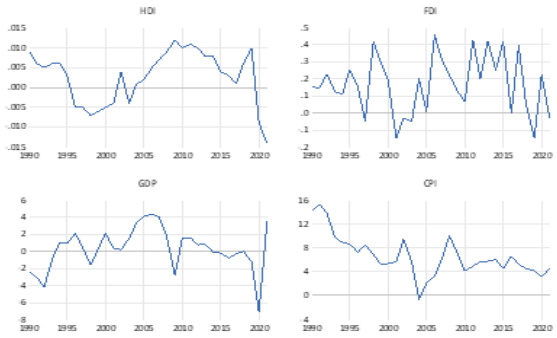
A key component of econometric analysis is stability testing because unstable variable relationships can produce unreliable and misleading conclusions. Stability testing in econometrics is the study of the consistency or stability of links between economic variables throughout time. It looks at whether a model's statistical characteristics and parameters remain consistent as well as reliable across time periods or sub-samples.

In econometrics, there are different methods and approaches for conducting stability tests, and the method employed depends on the context as well as the question. CUSUM Testing is one of the tests of used to test stability. The Cumulative Sum of Squares test is a graphical tool for determining the stability of regression parameters over time. It illustrates the total difference between the predicted parameters as well as their mean values; assisting researchers detect any systematic deviations or shifts.

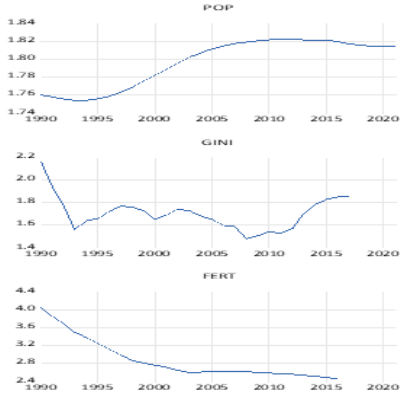
4. Findings and discussion

4.1. Visual inspection

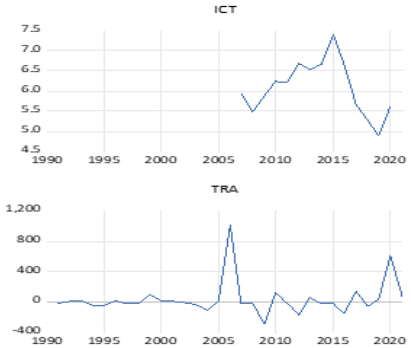
Economic Indicators **(**HDI, GDP, FDI, and UNE), Demographic indicators (POP, GINI, and FERT) and Policy framework (ICT, TRA) are the variables that are used for visual inspection. If it is discovered that the variables in question have unit root (non-stationary) levels, the variables are compared and the unit root test is repeated. **Figure 1** represents illustrations that give a graphic and informal perception of stationarity.



Economic Indicators



Demographic indicators



Policy framework

Figure 1. Visual inspection.

4.2. Unit root tests

Augmented Dicky-Fuller (ADF) was employed to determine the explanatory variable's stationarity. **Table 2** below shows the results of the ADF test. Since this study will be analyzing time series data, it is critical to investigate the characteristics of numerous elements to avoid misleading regression issues. Understanding non-stationarity is critical because it aids in determining the best model for projection when the analysis period extends and panels vary over time.

1) Augmented Dicky-Fuller Tests.

Table 2. Unit root test results (augmented Dicky-Fuller test at first difference with trend and intercept (economic indicators/demographic indicators/policy framework)).

Variables	*P*-Value: Level Test Statistic	*P*-Value: First Difference Test Statistic	*T*-Statistics: Level	*T*-Statistics: 1st Difference	Critical Values			Order of Integration
					1%	5%	10%	
HDI	0.8612	0.0005	−1.3302	−5.5005	−4.2967	−3.5683	−3.2183	Non-Stationary I (0) at level and first difference I (1)
CPI	0.0304	0.0004	−3.8035	−5.7319	−4.3393	−3.5875	−3.2292	Stationary I (0) at level form and first difference Stationary I (1) at all critical values (1%)
FDI	0.0012	0.0000	−5.1558	−10.003	−4.2967	−3.5684	−3.2184	Stationary I (0) at level form and first difference Stationary I (1) at all critical values (1%)
GDP	0.0442	0.0002	−3.6221	−5.9064	−4.2967	−3.5683	−3.2183	Stationery I (0) at level form and first difference Stationary I (1) at all critical values (1%)
UNE	0.9929	0.0070	0.1177	−5.1267	−4.2846	−3.5628	−3.2152	Non-Stationary I (0) at level but Stationery at first difference I (1)
POP	0.0102	0.0343	−4.3150	−3.7908	−4.3743	−3.6032	−3.2380	Stationary I (0) at level form at all critical values (1%)
FERT	0.8128	0.0001	−1.4859	−6.0533	−4.2967	−3.5684	−3.2184	Non-Stationary I (0) at level but Stationery at first difference I (1)
GINI	0.0232	0.0001	−3.9567	−6.6132	−3.7115	−2.9810	−2.6299	Stationary I (0) at level form at all critical values (1%)
TRA	00411	0.0006	−3.6764	−5.5831	−4.3098	−3.5742	−3.2217	Stationary I (0) at level form at all critical values (1%)
ICT	0.4352	0.0411	−2.2733	−3.6763	−4.3240	−3.5806	−3.2253	Stationary at first difference I (1) at all critical values (1%)

Source: Author's computation from EViews 12.

- At significance levels of 1%, the ADF test suggests that Human Development index and Unemployment variables are stationary at first difference. Meanwhile all other variables demonstrate stationarity both at level when utilizing models with both trend and intercept.
- At significance levels of 1% the ADF test suggests that Fertility rate is stationary at first difference. Meanwhile all other variables demonstrate stationarity at level when utilizing models with both trend and intercept.
- At significance levels of 1%, the ADF test suggests that ICT demonstrates that the variables are stationary at first difference; meanwhile TRA demonstrates stationarity at level when utilizing models with both trend and intercept.

The below **Table 3** shows additional results of Unit Root Test, which also confirms the ADF results above.

2) Philip-Perron tests.

Table 3. Unit root test results (Philip-Perron test at first difference with trend and intercept (economic indicators/demographic indicators/policy framework)).

Variables	Level test statistic	First Difference test statistic	Level Adj. *T*-Statistics	Level Adj. *T*-Statistics	Critical Values			Order of Integration
					1%	5%	10%	
HDI	0.8612	0.0005	−1.3302	−5.5005	−4.2967	−3.5683	−3.2183	Non-Stationary I (0) at level but first difference I (1)
CPI	0.3427	0.0000	−2.4630	−8.9782	−4.2967	−3.5684	−3.2184	Non-Stationary I (0) at level but first difference I (1)
FDI	0.0012		−5.1557		−4.2845	−3.5628	−3.2153	Stationary I (0) at level form
GDP	0.0529	0.0000	−3.5353	−9.1717	−4.2967	−3.5683	−3.2183	Stationary I (0) at level form
UNE	0.7828	0.0066	−1.4907	−5.1714	−4.8864	−3.8289	−3.3629	Non-Stationary I (0) at level but first difference I (1)
POP	0.0000		−5.8948		−2.6416	−1.9521	−1.6140	Stationary I (0) at level form
FERT	0.8578	0.0000	−1.3423	−8.5349	−4.2967	−3.5684	−3.2184	Non-Stationary I (0) at level but Stationery at first difference I (1)
GINI	0.3621	0.0007	−0.7953	−3.6578	−2.6569	−1.9544	−1.6093	Stationary I (0) at level form
TRA	0.0000		−13.258		−3.6701	−2.9621	−2.6210	Stationary I (0) at level form
ICT	0.3543	0.0007	−2.4380	−5.3858	−4.2967	−3.5683	−3.2184	Stationary at first difference I (1)

4.3. ARDL bounds testing

4.3.1. Economic indicators (consumer price index, gross domestic product, foreign direct interest & unemployment rate)

Table 4 shows there is cointegration if the *f*-stats are higher than the critical value of the upper bound and no cointegration if the *f*-stats is lower than the critical value of the lower bound. The computed *F*-value, as indicated by this result, is 6.16, which is higher than both the upper and lower bounds tests. At the 1% significant level, the upper bound's critical value is 5.72. This suggests that there is a cointegrating link between HDI and UNE, FDI, and GDP, hence rejecting the null hypothesis that there is no cointegrating relationship.

ARDL Bounds testing.

Table 4. Bounds testing results.

Test Statistic	Value	Significant	Lower bound	Upper bound
F-statistic	6.169854	10%	3.03	4.06
K	4	5%	3.47	4.57
		2.5%	3.89	5.07
		1%	4.4	5.72

Source: Author's computation from EViews 12.

There is a statistically negative significant relationship between Human Development index and Foreign Direct Index. This implies that a 1% increase in FDI will, on average, results in a 1.96% decrease in HDI. The findings indicate a statistically significant negative relationship between the Human Development Index (HDI) and Foreign Direct Investment (FDI). This finding appears to contradict the

work of Syafri and Firdayeti (2022) who found a positive impact of FDI on HDI. Benefits from FDI that are not distributed equally throughout the population have the potential to exacerbate already-existing disparities and lower the HDI for particular communities. This can happen if foreign direct investment (FDI) flows concentrate on enclave industries that provide mostly repatriated profits and few local jobs. Reiter and Steensma (2010), who claimed that FDI helps the process of human growth, dispute this.

Table 5 results show that the error correction term is negative and significant, with a probability value of 0.001 and a coefficient of −0.287, which is an indication of the speed of adjustment from a period of disequilibrium to a period of disequilibrium to a of equilibrium. Ozturk and Acaravci (2010) cited that for short-run disequilibrium dynamics to return to long-run equilibrium, the error correction term must be negative and statistically significant. Jadoon et al. (2015) add that if the error correction term is positive, the model ought to be questioned. Furthermore, the 28.7% of disequilibrium is adjusted for the next period or system corrects its previous period disequilibrium at a speed of 26.6% within one period.

Table 5. Long-run & short-run analysis.

Long-Run: Estimation				
Variable	**Coefficient**	**Std. Error**	***t*-Statistic**	**Prob.**
D(GDP)	0.003427	0.001953	1.754726	0.1397
D(FDI)	−0.019564	0.001156	−0.855572	0.0216
D(CPI)	−0.000897	0.000785	−1.143531	0.3046
C	0.005681	0.043700	0.130001	0.9016
ARDL Short-Run Analysis				
Variable	**Coefficient**	**Std. Error**	***t*-Statistic**	**Prob.**
D(GDP)	0.001564	0.000243	6.439684	0.0013
D(FDI)	−0.015974	0.002256	−7.081280	0.0009
D(CPI)	−0.000897	0.000300	−2.986833	0.0306
CointEQ (−1) *	−0.287275	0.017937	−6.595999	0.0007

Source: Author's computation from EViews 12.
HDI = − (0.003427GDP − 0.019564FDI − 0.000897CPI) + 0.005681.

4.3.2. Demographic indicators (population rate, fertility rate and Gini index)

Table 6 shows that the calculated *F*-value is 8.54, which is above the upper, and lower bounds test. The critical value of the upper bound is 5.61 at 1% significant level. This means that the null hypothesis of no cointegrating relationship can be rejected, which implies that HDI is cointegrated with FERT, POP and GINI. Therefore, there is an existing long run relationship between variables.

1) ARDL bounds testing.

Table 6. Bounds test.

Test Statistic	**Value**	**Significant**	**Lower bound**	**Upper bound**
F-statistic	8.544489	10%	2.72	3.77
K	3	5%	2.79	4.35

Table 6. (*Continued*).

Test Statistic	Value	Significant	Lower bound	Upper bound
		2.5%	3.69	4.89
		1%	4.29	5.61

Source: Author's computation from EViews 12.

There is a statistically positive significant relationship between Human Development index and Fertility rate. This implies that a 1 percent increase in FERT will, on average, result in a 3.45 percent increase in HDI. There is a statistically positive significant relationship between Human Development index and Population rate. This implies that a 1% increase in POP will, on average, results in a 32.7% decrease in HDI. The findings support the negative, significant correlation between the fertility rate and the human development index. The long-run coefficient estimation results indicate that the rate of fertility and human development are inversely correlated. Couples can choose to have fewer children while still having the number of children they want when there is greater access to healthcare and education, which can reduce child mortality. Larger families may be encouraged to contribute to household income by better economic prospects. Hafner and Mayer-Foulkes (2013) did, however, acknowledge that there is a negative correlation between fertility and human development. The presented data validates a statistically significant positive correlation between the population rate and the Human Development Index.

The long-run coefficient estimation results show a direct correlation between the pace of population growth and human development. More people equate to a larger labor force, which can boost national growth and economic productivity. These gains can then be applied to improve health, education, and other HDI-related factors. These could also profit from economies of scale, which state that as the population grows, the cost of manufacturing products and services decreases. This can lead to lower costs and increased accessibility to essential goods and services for everybody. On the other hand, Asmita and Ruslan (2017) claimed that the North Sumatra Province's Human Development Index is unaffected by population growth.

Table 7 the results obtained from this study shows that the error correction term is negative and significant, with a probability value of 0.000 and a coefficient of −1.222, which is an indication of the speed of adjustment from a period of disequilibrium to a period of disequilibrium to a of equilibrium. The estimated coefficient for the error correction term (ECT) implies a 122.2% rate of adjustment to long-run equilibrium. In simplest terms, the system corrects 122.2% of the disequilibrium from the previous period in a single period. According to Narayan and Smyth (2006), an ECT coefficient between −1 and −2 indicates that equilibrium is achieved in a continually decreasing oscillatory way. In this instance, the ECT value corresponds with the theoretical expectation. As a result, this shows that there was no evidence of short run relationship FERT and POP but only for GINI.

2) Long run analysis.

Table 7. Long-run and short-run analysis.

Long-Run Analysis				
Variable	**Coefficient**	**Std. Error**	***t*-Statistic**	**Prob.**
GINI	−0.222008	0.007536	−1.255514	0.8306
FERT	0.034540	0.00600	5.757150	0.0000
POP	0.327076	0.067118	4.873176	0.0001
C	−0.646434	0.129546	−4.99005	0.0001
ARDL Short-Run Analysis				
D(GINI)	−0.0001635	0.0004605	−0.354989	0.7265
CointEQ (−1) *	−1.222008	0.141331	−8.646420	0.0000

Source: Author's computation from EViews 12.
HDI = − (−0.222008GINI + 0.034540FERT + 0.327076POP) − 0.646434.

4.3.3. Policy framework indicators (information communication technology & trade)

Table 8 above shows that the calculated *F*-value is 13.86, which is above the upper, and lower bounds test. The critical value of the upper bound is 5% at 1% significant level. This means that the null hypothesis of no cointegrating relationship can be rejected, which implies that HDI is cointegrated with ICT and TRA. Therefore, there is an existing long run relationship between variables.

1) ARDL bounds testing.

Table 8. Bounds test.

Test Statistic	**Value**	**Significant**	**Lower bound**	**Upper bound**
F-statistic	13.8577	10%	4.19	5.06
K	2	5%	4.87	5.85
		2.5%	5.79	6.59
		1%	6.34	7.52

Source: Author's computation from EViews 12.

There is a statistically negative significant relationship between Human Development index and Information Communication Technology. This implies that a 1% increase in ICT will, on average, results in a 0.0234 percent decrease in HDI. There is a statistically negative significant relationship between Human Development index and Trade. This implies that a 1% increase in TRA will, on average, results in a 2.99 percent decrease in HDI. The results reported confirms a negative significant relationship between Human development Index and Information Communication Technology. According to the results of the long-run coefficient estimation, there is an inverse relationship between Information Communication Technology and human development. Unequal access to and utilization of ICT can worsen existing inequalities and increase the digital gap, limiting access to healthcare, schooling, and economic opportunities, ultimately affecting HDI.

On contrary, other authors like Khan et al. (2019) argued that the empirical results reveal that ICT promote human development index. The results reported

confirm a negative significant relationship between Human development Index and Trade. According to the results of the long-run coefficient estimation, there is an inverse relationship between Trade and Human development Index. The unequal distribution of Trade benefits may result in the closing down of domestic industries and the loss of jobs in industries that are unable to compete with international goods. It can have an adverse effect on livelihoods and lead to poverty, which will affect HDI. Furthermore, Sana et al. (2020) argued that trade had a favorable and considerable impact on human development.

Table 9 above shows that the error correction term is negative and significant, with a probability value of 0.000 and a coefficient of −0.266, which is an indication of the speed of adjustment from a period of disequilibrium to a period of disequilibrium to a of equilibrium. Therefore, this implies that the speed of adjustment towards the long run equilibrium is 26.6% or system corrects its previous period disequilibrium at a speed of 26.6% within one period. As a result, this shows that there was no evidence of short run relationship ICT and TRA (Policy Framework) and HDI.

2) Long run analysis.

Table 9. Long-run and short-run analysis.

Long-Run				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
ICT	−0.002990	0.001302	−2.296031	0.0473
TRA	−0.000234	−0.000048	−4.795997	0.0010
C	0.023402	0.009071	2.579817	0.0297
ARDL Short-Run Analysis				
CointEQ (−1) *	−0.26576	0.037397	−7.128231	0.0001

Source: Author's computation from EViews 12.
HDI = − (−0.002990ICT − 0.000234TRA) + 0.023402.

4.4. Diagnostic results

Figure 2 above shows that the Jarque-Bera (JB) test confirms that the residuals have a normal distribution. The null hypothesis of the test states that the residuals are normally distributed. The *p*-value is 0.74, which suggests that the residuals are normally distributed. In other words, we cannot reject the null hypothesis.

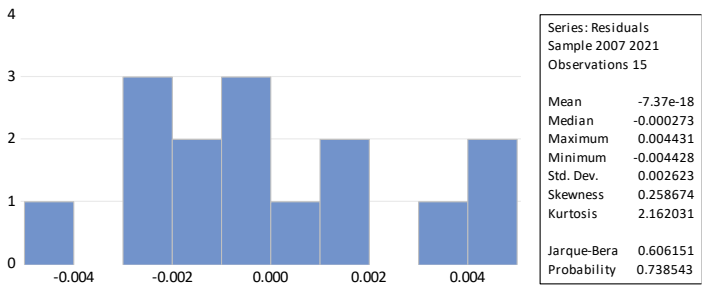


Figure 2. Normality test.

Source: Author's computation from EViews 12.

The Breusch-Pagan Godfrey Test proves that the residuals obtained from the

ARDL Model are free from Heteroskedasticity. The Obs. *R*-squared 3.65 and Pro. Chi-Square is 0.46. Therefore, we fail to reject the null hypothesis and we conclude that there is no heteroscedasticity. **Table 10** displays the results of the LM test, the Durbin Watson stats of the model lies between 1.5 and 2.0. The results for we have for Economic indicators and Human development index it is 2.0. Therefore, we fail to reject the null hypothesis and we conclude that there is no serial correlation. **Table 9** shows Ramsey RESET Test was used to the appropriate functional form. The probability value of *F*-Statistics is 0.08 suggesting that the model is well specified.

1) Economic Indicators (Consumer Price Index, Gross Domestic Product, Foreign Direct Interest &Unemployment).

Table 10. Diagnostic tests for economic indicators and human development index.

Heteroskedasticity Breusch-Pagan Godfrey Test			
F-statistics	0.8029	Prob. *F*	0.5504
Obs* R-Squared	3.6466	Prob. Chi-Square	0.4559
Scaled explained SS	0.9417	Prob. Chi-Square	0.9185
Serial Correlation LM test			
F-statistics	Durbin Watson Stats	Prob. *F*	
0.64843	2.0	0.5483	
Ramsey RESET Test			
	Value	Prob.	
t-statistic	1.9402	0.084	
F-statistic	3.7642	0.084	

Source: Author's computation from EViews 12.

The CUSUM tests, introduced by Brown et al. (2008) in 1975, are used to determine the stability of a significant relationship between variables. **Figure 3** remained between the 5% critical bounds (portrayed by two straight lines) which prove the stability of the parameter, indicating a consistent and significant relationship among the variables.

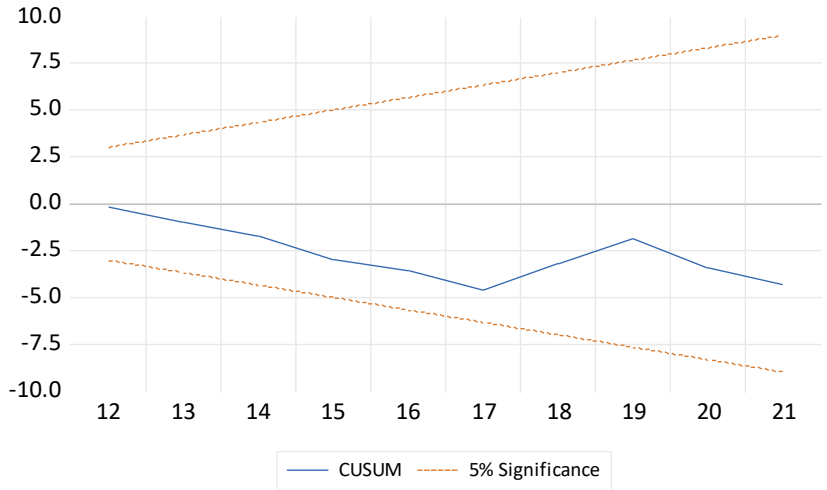


Figure 3. CUSUM test.

Source: Author's computation from EViews 12.

Figure 4 shows that the Jarque-Bera (JB) test is used to determine whether the residuals have a normal distribution. The null hypothesis of the test states that the residuals are normally distributed. The *p*-value is 0.52, which suggests that the residuals are normally distributed. In other words, we cannot reject the null hypothesis.

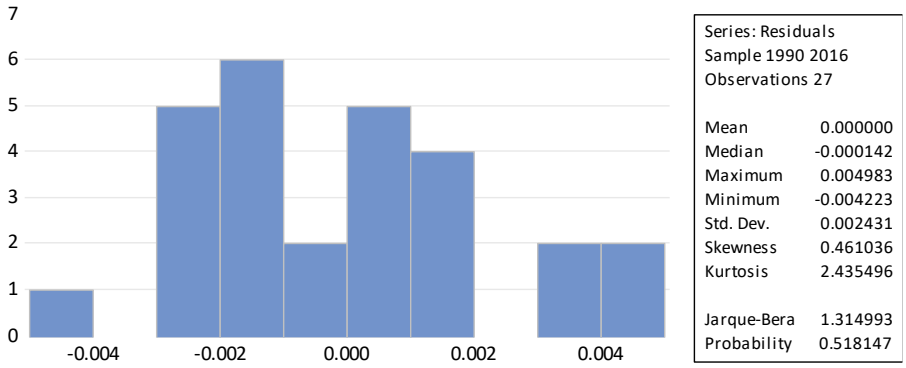


Figure 4. Normality test.

Source: Author's computation from EViews 12.

Table 11 shows proves that the residuals obtained from the ARDL Model are free from Heteroskedasticity. The Obs. *R*-squared 2.33 and Pro. Chi-Square is 0.51. Therefore, we fail to reject the null hypothesis and we conclude that there is no heteroscedasticity. **Table 11** displays the results of the LM test; the Durbin Watson stats of the model lies between 1.5 and 2.0. The results for we have for Demographic indicators and Human development index it is 1.54. Therefore, we fail to reject the null hypothesis and we conclude that there is no serial correlation. The **Table 9** Ramsey RESET Test was used to the appropriate functional form. The probability value of *F*-Statistics is 0.52 suggesting that the model is well specified.

2) Demographic indicators (population rate, fertility rate and Gini Index).

Table 11. Diagnostic tests for demographic indicators and human development index.

Heteroskedasticity Breusch-Pagan Godfrey Test			
F-statistics	0.72492	Prob. *F*	0.5475
Obs* R-Squared	2.33246	Prob. Chi-Square	0.5063
Scaled explained SS	1.21482	Prob. Chi-Square	0.7495
Serial Correlation LM test			
F-statistics	Durbin Watson Stats	Prob. *F*	
1.32581	1.54	0.3129	
Ramsey RESET Test			
	Value	Prob.	
t-statistic	0.65150	0.5215	
F-statistic	0.42445	0.5215	

Source: Author's computation from EViews 12.

Figure 5 remained between the 5% critical bounds (portrayed by two straight lines) which prove the stability of the parameter, indicating a consistent and significant relationship among the variables.

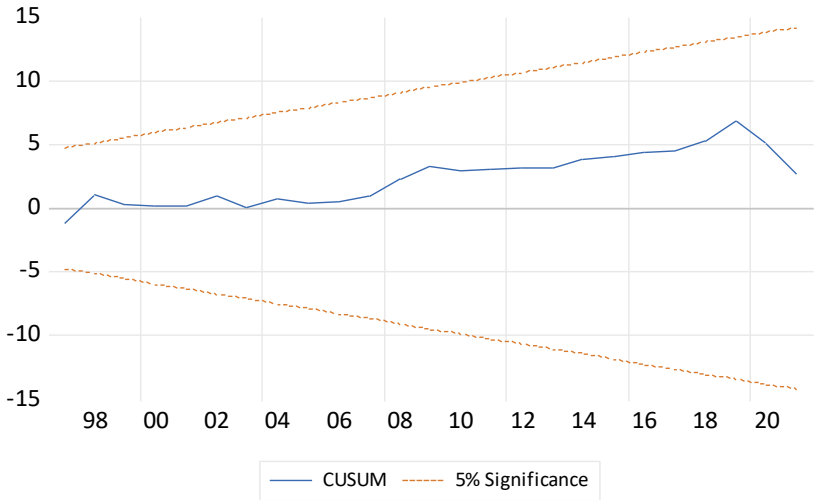


Figure 5. CUSUM test.

Source: Author's computation from EViews 12.

Figure 6 shows that the Jarque-Bera (JB) test is used to determine whether the residuals have a normal distribution. The null hypothesis of the test states that the residuals are normally distributed. The *p*-value is 0.89, which suggests that the residuals are normally distributed. In other words, we cannot reject the null hypothesis.

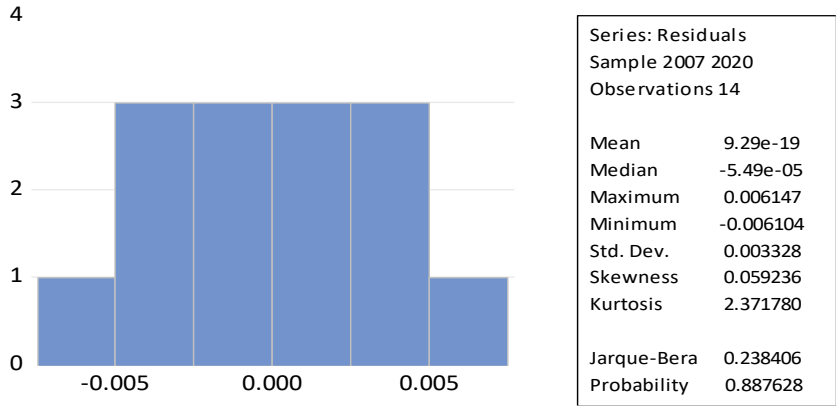


Figure 6. Normality test.

Source: Author's computation from EViews 12.

Table 12 shows that the residuals obtained from the ARDL Model are free from Heteroskedasticity. The Obs. *R*-squared 0.56 and Prob. Chi-Square is 0.76. Therefore, we fail to reject the null hypothesis and we conclude that there is no heteroscedasticity. **Table 12** displays the results of the LM test; the Durbin Watson stats of the model lies between 1.5 and 2.0. The results for we have for Policy Framework and Human development index it is 1.54. Therefore, we fail to reject the null hypothesis and we conclude that there is no serial correlation. **Table 11** shows Ramsey RESET Test was used to the appropriate functional form. The probability

value of *F*-Statistics is 0.17 suggesting that the model is well specified.

3) Policy Framework Indicators (Information Communication Technology & Trade).

Table 12. Diagnostic tests for policy framework and human development index.

Heteroskedasticity Breusch-Pagan Godfrey Test			
F-statistics	0.22855	Prob. *F*	0.7994
Obs* R-Squared	0.55855	Prob. Chi-Square	0.7563
Scaled explained SS	0.23651	Prob. Chi-Square	0.8885
Serial Correlation LM test			
F-statistics	Durbin Watson Stats	Prob. *F*	
0.51205	1.54	0.6062	
Ramsey RESET Test			
	Value	Prob.	
t-statistic	1.492594	0.1664	
F-statistic	2.227636	0.1664	

Source: Author's computation from EViews 12.

Figure 7 remained between the 5% critical bounds (portrayed by two straight lines) which prove the stability of the parameter, indicating a consistent and significant relationship among the variables.

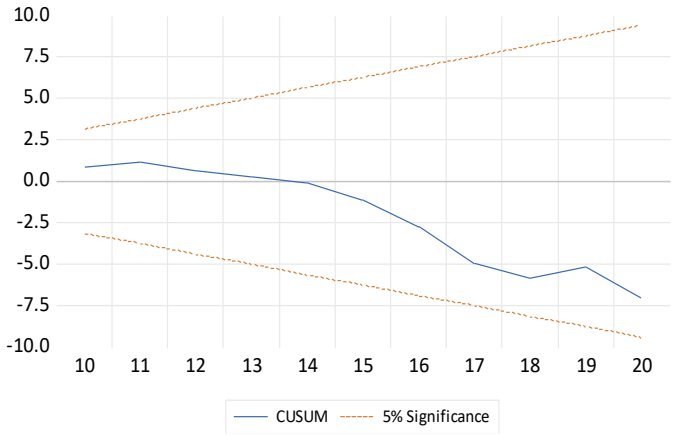


Figure 7. CUSUM test.

Source: Author's computation from EViews 12.

5. Summary, conclusions and recommendations

The relationship between economic, demographic, and policy framework factors on South Africa's Human Development Index (HDI) is examined in this study. Growth in GDP is a key factor in the HDI since it shows that there are more financial resources available for human development. However, through reducing purchasing power and creating uncertainty, high and fluctuating inflation can have a detrimental impact on an economy's HDI. Moderate and stable inflation often contributes to economic progress over the long term. Since high unemployment rates

are a sign of social insecurity and wasted human potential, they may be detrimental to HDI. A reduction in foreign direct investment (FDI) could have a negative long-term impact on HDI by causing investment and job creation to drop.

South Africa has one of the highest Gini indices in the world, according to demographic metrics, which may have an impact on HDI. Increased labor force participation can result from high income disparity, and population increase can either support economic expansion or put a pressure on infrastructure and public services. The average number of children born to women in reproductive age is measured by the fertility rate, which is correlated with HDI and has an impact on productivity and economic growth. Increases in ICT have a negative impact on an economy's HDI because unequal access to ICT can exacerbate already-existing economic disparities and disadvantage communities and people in terms of overall well-being, employment prospects, and educational chances. A rise in TRA can also lead to businesses reducing jobs as they struggle to compete with imports, leading to increased poverty and unemployment, negatively impacting people's health, education, and standard of living.

The Human Development Index (HDI) has been the subject of both positive and negative effects in previous research. Some scholars, such as Reiter and Steensma (2010), contend that foreign direct investment (FDI) promotes development, while Miraç et al. (2014). There is a negative correlation between the HDI and the Gini coefficient and the percentage of the poor (Astuti, 2018). Population growth has no effect on human development, but fertility does. Trade has a good effect, but ICT fosters growth, according to Khan et al. (2019). This study found a complex pattern of relationships among variables and HDI in South Africa, with significant relationships but varied impact sizes. Further research is needed to understand the root causes and inform successful policy actions.

In conclusion, this study examined the relationship between economic, demographic, and policy framework factors on South Africa's Human Development Index (HDI). The investigation indicated a complex interplay of variables, with both positive and negative factors influencing HDI. As expected, GDP growth boosts HDI, but high and fluctuating inflation might stymie development. Unemployment has a negative impact, emphasizing the need for creation of jobs methods. Foreign direct investment appears to have a favorable impact on HDI. South Africa's high Gini index, which measures economic inequality, is a concern. The impact of fertility rates on HDI requires further investigation. While greater access to information and communication technologies (ICT) might boost development, inequality in access can worsen existing disparities. Similarly, trade openness, while potentially advantageous, might result in employment losses in specific industries if not managed properly. Overall, the study demonstrates the diverse character of the factors influencing HDI in South Africa.

This study examined the relationship between economic, demographic, and policy framework factors on South Africa's Human Development Index (HDI). The investigation indicated a complex interplay of variables, with both positive and negative factors influencing HDI. As expected, GDP growth boosts HDI, but high and fluctuating inflation might stymie development. Unemployment has a negative impact, emphasizing the need for creation of jobs methods. Foreign direct

investment appears to have a favorable impact on HDI. South Africa's high Gini index, which measures economic inequality, is a concern. The limitations of the study are increased labor force participation can be advantageous, but population growth must be carefully managed to avoid overburdening resources. The impact of fertility rates on HDI requires further investigation. While greater access to information and communication technologies (ICT) might boost development, inequality in access can worsen existing disparities. Similarly, trade openness, while potentially advantageous, might result in employment losses in specific industries if not managed properly. Overall, the study demonstrates the diverse character of the factors influencing HDI in South Africa. Significant correlations exist; however, the impact of each element varies. Further research is required to understand the underlying causes of these interactions.

Recommendations

1) Over the past few years, South Africa's development has declined, despite having a medium level of human development. In order to solve this, the government needs to encourage engagement and communication between different racial, ethnic, and cultural groups in order to create social coherence and reconciliation. It is critical to implement inclusive policies that promote equal access to opportunities and resources for all citizens, irrespective of their background.
2) The findings of the ARDL Boundary tests demonstrate cointegration on the policy framework, demographic, and economic variables. Financial resources for citizen well-being programs, initiatives, and services should be allotted by the government, which should also assess its spending and develop practical plans for boosting the economy, lowering poverty, and reducing inequality.
3) Investing in education and skill development can help reduce poverty and enhance living conditions. Examples of these investments include providing quality early childhood education programs, universal access to primary and secondary education, increased funding for underprivileged schools, and vocational and technical training. Access to secure and reasonably priced housing can greatly enhance the wellbeing of families and people, particularly the underprivileged.
4) A more fair and balanced society can be achieved by implementing inclusive policies that support rural development and equal opportunity for all citizens. Investing in public Wi-Fi hotspots, establishing new financing options for small and medium-sized businesses (SMEs), and putting universal service and access regulations into place can all help to advance the growth and prosperity of the nation.

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