Geojournal of Tourism and Geosites
ISSN 2065-0817, E-ISSN 2065-1198

Year XIX, vol. 65, no. 2, 2026, p.694-704
DOI 10.30892/gtg.65207-1712

# ESTIMATING THE EFFECTS OF TOURISM DEVELOPMENT, ELECTRICITY SUPPLY, AND POPULATION GROWTH ON ECONOMIC GROWTH IN SOUTH AFRICA

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**Citation:** Manaliyo, J.C. (2026). Estimating the effects of tourism development, electricity supply, and population growth on economic growth in South Africa. *Geojournal of Tourism and Geosites*, 65(2), 694–704. https://doi.org/10.30892/gtg.65207-1712

**Abstract:** Background: Tourism development, electricity supply, and population growth influence economic growth in countries. Studies on the influence of tourism development, electricity supply, and population growth, however, report contradicting results. Aim: This paper investigates the effects of tourism development, electricity supply, and population growth on economic growth in South Africa. The study used annual time-series data for the period 1989 to 2021. The independent variables are tourism development, electricity supply, and population growth, whereas the dependent variable is economic growth. The autoregressive distributed lag (ARDL) model was used to determine the effects of tourism development, electricity supply, and population growth on economic growth. Increasing population growth and electricity supply have a positive influence on economic development in the long run. A 1% increase in population growth and electricity leads to 2.58% and 1.51% increases in economic growth, respectively. In the short run, economic growth is affected by tourism development and electricity supply. South Africa's economy grows by 0.041% and 0.496% if tourism development and electricity supply increase by 1%. The results also show that tourism development, population growth, and electricity supply have a unidirectional causal relationship, running to economic growth. South Africa's economic growth benefits from tourism development in the short run, whilst population growth may benefit the economy in the long run. Electricity supply has positive effects on economic growth in the long and short run, affirming the influence of electricity supply on economic growth.

**Keywords:** tourism development, electricity supply, population growth, economic growth, ARDL model, paired Granger causality, South Africa

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## INTRODUCTION

Tourism development, electricity supply, and population growth are contributors to economic growth in countries. Different scholars posit that tourism development, electricity supply, and population growth promote economic growth (Brida et al., 2024; Dash et al., 2022; Ford & Olivera, 2024; Jan et al., 2021). The effect of tourism development on economic growth may be explained using the tourism-led economic growth hypothesis. The precept of the hypothesis is that tourism development accelerates economic growth by bringing foreign exchange reserves through inbound tourists, luring foreign direct investment, promoting infrastructure development, creating jobs for skilled and unskilled people, and increasing competitiveness (Balaguer & Cantavella-Jordá, 2002; Rookayyah et al., 2024; Statistics South Africa, 2016). Tourism can potentially accelerate economic growth in developing countries. However, countries may not experience steady and high economic growth without a sufficient and uninterrupted electricity supply. Access to a stable and sufficient electricity supply stimulates productivity and increases economic activities, leading to economic growth (Atchike et al., 2020; Dash et al., 2022; Inegbedion et al., 2024). Contemporary literature shows that slow economic growth in some countries, particularly in Africa, is attributed to inadequate electricity supply (Avordeh et al., 2024; Dagnachew et al., 2023). Power cuts and load shedding disrupt the production of goods and services, resulting in slow or interrupted economic growth (Avordeh et al., 2024). Equally important, economic growth requires people to produce and consume goods and services. Increasing population growth stimulates demand for products and services (Miladinov, 2023; Ryerson, 2024). The influence of population growth on economic growth has been reported in different studies (Mahmoudinia et al., 2020; Thuku et al., 2013).

Empirical studies on the influence of tourism development, electricity supply, or population growth on economic growth, however, have reported contradicting findings. Some studies found that tourism development, electricity supply, or population growth does not trigger economic growth (Karim & Amin, 2018; Majewski et al., 2022; Wahyua et al., 2022). Many scholars (Gajjar, 2017; Mulipa, 2023; Peterson, 2017; Siano & Canale, 2022), on the other hand, found a negative influence of tourism development, population growth, or electricity supply on economic growth. These contradicting findings are the motivation for conducting the current study. The motivation for this study was also triggered by the current stunted economic growth and electricity crisis in South Africa. This study investigates the effects of tourism development,

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electricity supply, and population growth on economic growth in South Africa. South Africa has been experiencing power shortages and stunted economic growth for years (African Development Bank Group, 2024; Ferragamo, 2023; Mackett, 2023). In the first quarter of 2025, for example, South Africa's economy grew only by 0.1% compared with the last quarter of 2024 (Statistics South Africa, 2025). This slow economic growth is attributed to the electricity supply crisis in the country (Ndubuisi et al., 2025). South Africa's population is growing, and this growth has a positive effect on increasing unemployment (Dhoba et al., 2025). However, the country has a vibrant tourism industry, which makes a relatively high contribution to its economy. In 2024, for example, the tourism industry contributed 9.4% to South Africa's economy (World Travel & Tourism Council, 2025). Understanding the effects of tourism development, electricity supply, and population may assist the South African government in developing policies that may stimulate economic growth.

## EMPIRICAL LITERATURE REVIEW

### 1. Interaction between tourism development and economic growth

The tourism industry is a major contributor to economic growth in countries. Previous studies have shown that tourism contributes to countries' economies directly and indirectly in various ways. It generates income and foreign exchange earnings, creates employment opportunities, and promotes foreign investment, competition, and infrastructure development (Imrani et al., 2025; Nguyen et al., 2025; Tiwari et al., 2025; World Travel & Tourism Council, 2024).

The effects of tourism on economic growth have been observed in both developed and developing countries (Bride et al., 2020; Liu & Wu, 2019; Mete, 2022). Studies on the relationship between tourism and the economy, however, report contradicting results. Some studies support the traditional hypothesis that tourism causes economic growth, implying that a unidirectional causality relationship runs from tourism to economic growth. For example, a study used panel data for 123 countries and found a unidirectional causal relationship that runs from tourism to economic development in countries with underdeveloped tourism and low levels of development (Cárdenas-García et al., 2024).

A one-way directional causality relationship, running from tourism to economic growth, was also reported in a study conducted in India (Mishra et al., 2011). Similarly, another study conducted in Saudi Arabia found that a 1% increase in tourism receipts causes a 0.834% increase in economic growth (Naseem, 2021). Muzekenyi et al. (2018) also reported similar results in South Africa. The country's economy grows by 1.577 when international tourism revenue increases by one unit. A positive effect of tourism on economic growth was also detected in developed countries. A study conducted in Spain reveals that the country's economy increases by 0.61% if tourism productivity increases by 10% (Liu & Wu, 2019).

Tourism development, on the other hand, is driven by economic growth. Empirical literature has shown that economic growth promotes tourism development (Mohamed & Younesse, 2013; Naseem, 2021; Odhiambo & Nyasha, 2020). A study conducted in South Africa, for example, found a unidirectional causality relationship flowing from economic growth to tourism in the long run (Odhiambo & Nyasha, 2020). Similar findings were also reported by a study conducted in Morocco and Tunisia, affirming a unidirectional causality from economic growth to international tourism receipts (Mohamed & Younesse, 2013). Economic growth stimulates the development of tourism infrastructure, investment, and tourism spending. Therefore, it is not surprising that economic growth leads to tourism development. Economic growth also means increased income per capita, meaning that people have disposable income to spend on tourism activities. Countries' economic growth lures tourist arrivals (Liu et al., 2025). Tourists may not want to travel to countries with poor or deteriorating economies. In line with this argument, a study carried out in Spain reveals that tourists from other European countries were less willing to visit Spain if economic prospects in the country were expected to deteriorate (Santamaria & Filis, 2019).

Interestingly, other studies reported a bidirectional relationship between tourism growth and the economy, meaning that tourism and the economy influence each other (Devi, 2022; Odhiambo & Nyasha, 2020; Paudel et al., 2024; Wijesekara et al., 2022). The relationship between economic growth and tourism development is sometimes neutral, indicating that neither tourism development nor economic growth has a causal relationship. Mete found that economic growth leads to tourism growth in some countries, whereas tourism growth and economic growth have no relationship in other countries (Mete, 2022).

### 2. Interaction between electricity supply and economic growth

Electricity supply plays a vital role in economic growth. It is fundamental for households, businesses, factories, organisations, and government institutions. Without electricity, a country's economic growth may halt or sluggish. Electricity is an indispensable input into the production process to speed up countries' economic growth (Rahman et al., 2023). The availability of electricity influences the work conditions, which may stimulate an increase in productivity (Inegbedion et al., 2024). Literature indicates that the effects of electricity supply on economic growth are inconclusive. Some studies found that electricity supply is an indispensable contributor to economic growth. The causal relationship between electricity and economic growth is unidirectional, and it runs from electricity to economic growth (Atchike et al., 2020; Dash et al., 2022; Ifeanyi & Choma, 2016; Mutumba et al., 2024). A study conducted in South Africa on the causal relationship between electricity supply and economic growth found a unidirectional causal relationship, running from electricity supply to economic growth (Khobai et al., 2016). A study conducted in Indonesia also found that changes in electricity supply result in changes in economic growth. To be precise, a reduction in electricity supplies reduced labour productivity, leading to an estimated loss of IDR 71.5 billion (USD 4.91 million) every year (Falentina & Resosudarmo, 2019).

Other studies show that the relationship between electricity supply and economic growth is from economic growth to electricity supply, indicating that economic growth triggers electricity supply and consumption (Dash et al., 2022; Siremo & Hassan, 2022). Economic growth increases economic activities, which may also increase electricity demand. Ultimately, electricity supply increases to meet the created demand for electricity. A study conducted in South Africa and Nigeria

found that energy consumption in South Africa goes up due to economic growth, whereas energy consumption boosts economic expansion in Nigeria (Okafor, 2012). Bonsu & Wang (2022) used data from 45 countries and found that energy consumption per capita swells by 0.0218% when economic growth increases by 1%. A study conducted in Pakistan also found a causal relationship flowing from economic growth to electricity supply (Azam et al., 2020). A one-way directional causality relationship from economic growth to electricity was observed in India (Mohapatra & Giri, 2020).

In some instances, economic growth and electricity supply influence each other. These variables have a bidirectional causality relationship. A bidirectional causality relationship between per capita electricity consumption and per capita GDP (Aneja & Mathpal, 2022). Khobai et al. (2016) also found a bidirectional causality between economic growth and electricity supply. When the electricity supply increases by 1%, economic growth grows by 3.94% in South Africa. In contrast, other studies found no causal relationship between electricity supply and economic growth (Botelho, 2019; Majewski et al., 2022). This neutrality hypothesis may imply that the economy is not performing well enough to stimulate the electricity demand. The supplied electricity may not be consumed sufficiently to promote economic growth. A study in Mongolia supports the neutrality hypothesis between GDP and energy consumption (Shagdarsuren et al., 2024).

### 2. Interaction between population growth and economic growth

Population is a major driver of the economy because it influences the production and consumption of goods and services. A decline in population growth affects the supply side and the demand side of the economy. It reduces the supply of the workforce, given that the population is the source of the workforce, leading to a reduction in production. On the other hand, a population decline has negative effects on the demand for produced goods and services. The opposite is true, that an increase in population stimulates the demand for and supply of goods and services (Lianos et al., 2023). The relationship between population growth and economic growth may be observed from two theories: population-led economic growth and economy-led population growth. Supporters of population-led economic growth theory argue that population growth means an increased workforce and consumers (Becker et al., 1999; Guga et al., 2015). This accentuates a unidirectional causality relationship that flows from population growth to economic growth (Abebaw, 2019; Furuoka, 2010). A study conducted in developing countries found that the growth of GDP per capita depends on population growth (Dao, 2012). A similar study found that a 1% increase in population results in a 0.38% increase in GDP when a fully modified ordinary least squares (FMOLS) estimator is used (Mahmoudinia et al., 2020).

However, it is not always that population growth boosts economic growth. Population growth sometimes encumbers economic growth, creating socio-economic problems such as poverty, illiteracy, unemployment, and exhaustion of natural resources (Filipenco, 2024; Gajjar, 2017). Population growth may become a burden to the economy when it is not controlled. Various studies support the argument that uncontrolled population growth cripples economic growth (Dao, 2012; Guga et al., 2015). A study in Bangladesh found that population growth and economic growth are negatively correlated. An increase in population harms economic growth in the country (Abdullah et al., 2015). The implication is that a decline in population growth may have a positive impact on economic growth. Dao (2012) found that a decline in population growth has a positive effect on economic growth. GDP per capita increases by 13.7% if the population growth declines by 1%. However, slow population growth may cause economic problems in developed countries, whereas high population growth impedes economic growth in developing countries (Peterson, 2017; Wilmoth et al., 2022).

The economy-led population growth theorists argue that economic growth promotes population growth. The expansion of the economy creates a conducive environment for population growth by improving living conditions and reducing socioeconomic problems (Guga et al., 2015). A study investigating a causal relationship between economic growth and population in developed countries, using data for the periods 1820 to 1938 and 1950 to 2016, affirms the importance of economic growth in population expansion. The study detected a unidirectional causality relationship from economic growth to the population for the period 1950 to 2016, but during the period 1820 to 1938, the causal relationship was from population growth to economic growth (Lianos et al., 2022). A study conducted in the Philippines also reported similar results, which reveal that economic growth promotes population growth. The causality relationship runs from economic growth to population growth (Furuoka, 2010). A study conducted in the Organisation of Islamic Cooperation (OIC) countries, however, found a bidirectional relationship between economic growth and population growth (Mahmoudinia et al., 2020), suggesting that both economic growth and population growth influence each other. In contrast, a study used in South Asian countries failed to detect a causal relationship between population growth and economic growth (Karim & Amin, 2018).

## METHODOLOGY

### 1. Data description and sources

This study used annual time series data for South Africa, with the sample period 1989 to 2021 (33 observations). This sample period was influenced by the availability of data. The independent variables are tourism development, electricity supply, and population growth, whereas the dependent variable is economic growth. International tourist arrivals were used as a proxy for tourism development, and gross domestic product was used as a proxy for economic growth. Similarly, electricity supply is presented by the electricity generated available for distribution in South Africa.

This electricity is generated by Eskom (a power utility). The data for tourist arrivals (TA), economic growth (GDP in current $), and population growth (PG) were obtained from the World Development Indicators, which are accessed from the World Bank's website (World Bank Group, 2025). The data for electricity supply was accessed from the website of Statistics South Africa (Statistics South Africa, n.d). A trend analysis of the variables was conducted, and the results are presented in Figure 1. The results show that the electricity supply (ES) was increasing at a high rate from 1989 to 2007.

Then, South Africa started experiencing the electricity crisis. South Africa's economy (GDP) was increasing steadily from 1989 to 2018, and the economy started declining. Population growth (PG) is the only variable with constant growth throughout the sample period. With respect to tourism development (TA) that tourist arrivals sharply declined in 1991 from above 8,000,000 tourists to below 2,000,00 tourists. Then, tourist arrivals started increasing but a low rate until 2019 due to the travel restrictions caused by the COVID-19 pandemic.

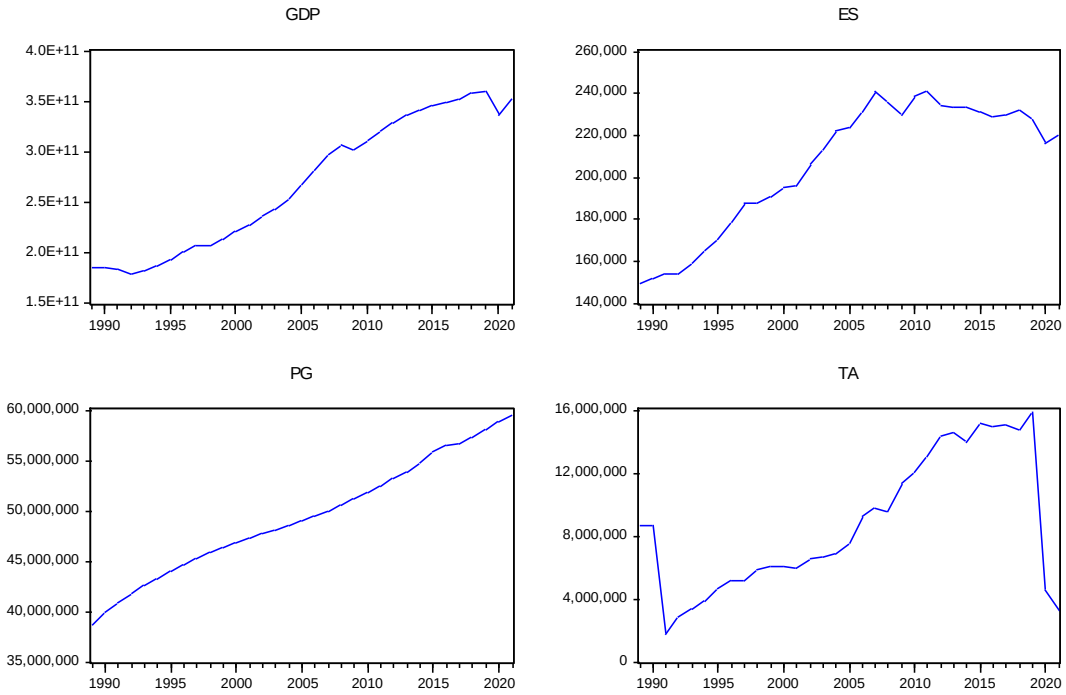


Figure 1. Trends of variables (Source: Author's compilation)

The data were transformed into a natural logarithm because the data did not meet some of the preconditions for the ARDL model. Logarithmic transformation of data reduces the variance and skewness of variables (West, 2022).

The transformed variables became lnGDP, lnTA, lnES, and lnPG. After data transformation, descriptive statistics and correlation tests were conducted to describe the data. The results from descriptive statistics and correlation tests are presented in Table 1. The results in Table 1 show that the mean of electricity supply (lnES) is 12.22524 with a standard deviation of 0.158578. The mean of economic growth (lnGDP) is 26.28578 with a standard deviation of 0.253969, and the mean of population growth (lnPG) is 17.70873 with a standard deviation of 0.118791.

The mean of tourism development (lnTA) is 15.83503 with a standard deviation of 0.573920. The results also indicate that the dataset follows a normal distribution because the skewness of the study variables falls between -1 and 1.

Table 1. Descriptive statistics and correlation (Source: Authors' compilation)

| **Descriptive statistics** | | | | |
|---|---|---|---|---|
| | lnES | lnGDP | lnPG | lnTA |
| Mean | 12.22524 | 26.28578 | 17.70873 | 15.83503 |
| Median | 12.30579 | 26.31256 | 17.70768 | 15.83281 |
| Maximum | 12.39300 | 26.60803 | 17.89967 | 16.57712 |
| Minimum | 11.91653 | 25.91265 | 17.47054 | 14.35174 |
| Std. Dev. | 0.158578 | 0.253969 | 0.118791 | 0.573920 |
| Skewness | -0.764881 | -0.147473 | -0.158723 | -0.52755 |
| Kurtosis | 2.133195 | 1.432601 | 2.102598 | 2.647482 |
| Jarque-Bera | 4.250846 | 3.497631 | 1.245893 | 1.701566 |
| Probability | 0.119382 | 0.173980 | 0.536362 | 0.427080 |
| Sum | 403.4330 | 867.4308 | 584.3882 | 522.5559 |
| Sum Sq. Dev. | 0.804701 | 2.064001 | 0.451559 | 10.54029 |
| Observations | 33 | 33 | 33 | 33 |
| **Correction** | | | | |
| lnES | 1.000000 | | | |
| lnGDP | 0.914642 | 1.000000 | | |
| | 0.000000 | | | |
| lnPG | 0.876226 | 0.962288 | 1.000000 | |
| | 0.000000 | 0.000000 | | |
| lnTA | 0.69936 | 0.711935 | 0.579922 | 1.000000 |
| | 0.000000 | 0.000000 | 0.000000 | |

The correlation results show that the correlation coefficient (0.914642) of economic growth and electricity supply is positive and statistically significant. This indicates that these two variables are strongly correlated. Population growth is also statistically and strongly correlated with electricity supply and economic growth. Tourism development is moderately and positively correlated with electricity supply and population growth (Table 1).

**2. Model specification**

The autoregressive distributed lag (ARDL) model, developed by Pesaran & Shin (1995), was applied to determine the long-run relationship among the study variables. The unit root test was first conducted to determine whether the study variables met the criterion for the ARDL model. The rule is that the ARDL model is only used in the analysis of data if study variables are stationary at level I(0) or at the first difference I(1), and no study variable is stationary at the second difference I(2). The ARDL model can still be applied even if the order of integration is a combination of I(0) and I(1) (Pesaran et al., 2001). The stationarity of the variables was determined by conducting different unit root tests, which are the Augmented Dickey-Fuller (ADF), Kwiatkowski-Phillips-Schmidt-Shin (KPSS), and Phillips and Perron (PP) under the null hypothesis that the study variables have a unit root.

The initial model to test the relationship among the study variables is as follows:

$$\text{lnGDP} = f\ (\text{lnTA, lnES, lnPG}) \quad (1)$$

Where $f\ is$ the function notation. The ARDL model specification for the relationship among the study variables is derived from the above model (1) and the model is as follows:

$$lnGDP_t = \beta_0 + \ \varphi_{1j}\, ln\, TA_{t-i} + \varphi_{2j}\, ln\, ES_{t-i} + \ \varphi_{3j}\, ln\, PG_{t-i} + e_t \quad (2)$$

Where $\beta_0$ is a constant, and the coefficients of the long-run relationship among the study variables are represented by $\varphi_{1j}$, $\varphi_{2j}$ and $\varphi_{3j}$. lnGDP stands for economic growth (GDP) in logarithms at time t; lnTA represents tourist arrivals in logarithms at time t; lnES denotes electricity supply in logarithms at time t; and lnPG represents population growth in logarithms at time t. The error correction is represented by $e_t$. The regression equation for cointegration is, therefore, expressed as follows:

$$\Delta lnGDP_t = \beta_0 + \Sigma_{j=1}^{k}\varphi_{1j}\Delta lnTA_{t-j} + \Sigma_{j=1}^{k}\varphi_{2j}\Delta lnES_{t-j} + \Sigma_{j=1}^{k}\varphi_{3j}\Delta lnPG_{t-j} + \gamma_{1j}\Delta lnTA_{t-j} + \gamma_{2j}\Delta lnES_{t-j} + \gamma_{3j}lnPG_{t-1} + e_t \quad (3)$$

The symbol $\Delta$ in the equation above, symbolises a change in the value of the study variables (economic growth, tourist arrivals, electricity supply, and population growth). On the other hand, $\gamma_{1j}$ , $\gamma_{2j}$ and $\gamma_{3j}$ are the coefficients of the short-run relationship between variables. Therefore, the hypotheses for testing the bounds for cointegration are:

$$H_O: \varphi_{1j} = \varphi_{2j} = \varphi_{3j}\ H_1: \gamma_{1j} \neq \gamma_{2j} \neq \gamma_{3j}$$

The existence of a long-run relationship among the study variables was determined by performing a bounds cointegration test, where the computed F-statistic value was compared with the critical values of the lower bound, I(0), and the critical value of the upper bound, I(1). The rule of thumb is that study variables have a long-run relationship only if the computed F-statistic value is greater than the critical values of the lower bound and upper bound. The null hypothesis is not rejected if the computed F-statistic value is smaller than the critical values of the lower bound (Pesaran et al., 2001). If the bounds cointegration test indicates that there is a long-run relationship among study variables, then the adjustment of the disequilibrium triggered by short-run shocks is determined using the error correction model (ECM). The equation for determining the establishment of the disequilibrium is expressed below.

$$\Delta lnGDP_t = \beta_0 + \Sigma_{j=1}^{k}\varphi_{1j}\Delta lnTA_{t-j} + \Sigma_{j=1}^{k}\varphi_{2j}\Delta lnES_{t-j} + \Sigma_{j=1}^{k}\varphi_{3j}\ \Delta lnPG_{t-j} + \gamma_{1j}\Delta lnTA_{t-j} + \gamma_{2j}\Delta lnES_{t-j} + \gamma_{3j}lnPG_{t-1} + ECT_{t-1} + e_t \quad (4)$$

Where, $ECT_{t-1}$ symbolises the error correction term. Furthermore, residual diagnostic and stability tests were performed to determine the suitability of the ARDL model in this study.

## RESULTS AND DISCUSSION

**1. Results of unit root tests**

Unit root tests were performed to identify the order of integration, and the results depicted in Table 2 show that no variable is stationary at the second difference, I(2).

The variables are stationary at level I(0) and at the first difference I(1). Given that the order of integration is a mixture of I(0) and I(1), the ARDL model was employed to determine the relationship among the study variables.

Table 2. Unit root test results (Source: Authors' compilation)

| Variable | Order of integration | | lnES | lnGDP | lnPG | lnTA |
|---|---|---|---|---|---|---|
| ADF (t-statistic) | I(0) | Intercept | -2.95711 | -2.95711 | -2.963972 | -2.95711 |
| | | Trend & intercept | -3.56838 | -3.55775 | -3.587527 | -3.55775 |
| | I(1) | Intercept | -2.96777 | -2.96041* | -2.96397* | -2.96041* |
| | | Trend & intercept | -3.56838* | -3.56288* | -3.568379 | -3.56288* |
| KPSS (LM-Stat) | I(0) | Intercept | 0.46300* | 0.46300* | 0.463000* | 0.46300* |
| | | Trend & intercept | 0.14600* | 0.14600 | 0.146000 | 0.14600 |
| | I(1) | Intercept | 0.46300* | 0.46300 | 0.463000 | 0.46300 |
| | | Trend & intercept | 0.14600 | 0.14600* | 0.146000* | 0.14600 |
| PP (t-statistic) | I(0) | Intercept | -2.95711 | -2.95711 | -2.957110 | -2.95711 |
| | | Trend & intercept | -3.55776 | -3.55776 | -3.55776* | -3.55776 |
| | I(1) | Intercept | -2.96041* | -2.96041* | -2.96041* | -2.96041* |
| | | Trend & intercept | -3.56288* | -3.56288* | -3.56288* | -3.56288* |
| **Order of integration** | | | **I(1)** | **I(1)** | **I (1)** | **I(1)** |

**2. Bounds for cointegration results**

The result of bounds for the cointegration test (Table 3) indicates that the value (14.03397) of the calculated F-statistic is greater than the critical value (4.306) of the upper bound, I(1), and the critical value (2.790) of the lower bound at a 5% significance level. This result leads to the decision to reject the null hypothesis that there is no long-run relationship among the study variables. Therefore, the alternative hypothesis that the study variables have a long-run relationship was accepted. The optimal lag selection was automatic, and the Akaike Information Criterion (AIC) method was used.

Table 3. Bounds for cointegration results (Source: Authors' compilation)

| Test statistic | Value | | Sample size | 10% | 5% | 1% |
|---|---|---|---|---|---|---|
| F-statistic | 14.03397 | I(0) | 30 | 2.676 | 3.272 | 4.614 |
| | | I(1) | 30 | 3.586 | 4.306 | 5.966 |
| | | I(0) | Asymptotic | 2.370 | 2.790 | 3.650 |
| | | I(1) | Asymptotic | 3.200 | 3.670 | 4.660 |

**3. Long-run coefficients**

The results presented in Table 4 below indicate that population growth affects economic growth. The coefficient (2.584021) for population growth is positive and statistically significant (p-value = 0.0052) at 5% level. This implies that South Africa's economy would grow by 2.58% in the long run when the population increases by 1%. An increase in population growth results in an increased workforce that may contribute to the production of goods and services. An increase in population growth will also increase the demand for goods and services. Then, the increased production and consumption of goods and services stimulate economic growth. This result supports the population-led economic growth hypothesis that population growth stimulates economic growth. Population growth increases the workforce and creates demand for goods and services (Becker et al., 1999; Guga et al., 2015; Lianos et al., 2023).

This result also supports previous empirical studies that reveal that an increasing population promotes economic growth. For example, a study in OIC countries shows that a 1% increase in population growth leads to an increase (0.38%) in GDP (Mahmoudinia et al., 2020). The current results also indicate that the electricity supply plays an influential role in South Africa's economy. The coefficient (1.510898) for the electricity supply is positive and statistically significant (p-value = 0.0265) at 5% level, suggesting that the economy grows by 1.51% in the long run if the electricity supply increases by 1%. South Africa has been experiencing an electricity crisis that has adversely affected every facet of the country's economy, including businesses and households (Ferragamo, 2023; Mackett, 2023). This electricity crisis impedes South Africa's economic growth because the operations of businesses, organisations, and government institutions are often interrupted, reducing productivity. Therefore, it is not surprising that an increase in South Africa's electricity supply boosts economic growth. Previous studies in different countries, including South Africa, also found that electricity supply promotes economic growth (Atchike et al., 2020; Dash et al., 2022; Mutumba et al., 2024). Extensive literature shows that tourism development has positive effects on economic growth (Liu & Wu, 2019; Muzekenyi et al., 2018; Naseem, 2021). South African tourism is a major contributor to the country's economy (World Travel & Tourism Council, 2025), but this study did not find evidence that tourism development promotes South Africa's economic growth in the long run. The coefficient (-0.331886) for tourism development (lnTA) is negative and is not statistically significant (p-value = 0.2128) at 5% level. This result is unexpected.

The lack of a positive effect of tourism development on economic growth is because other economic sectors in the country are underperforming. It is argued that the economic contribution of tourism development alone is too small to cause any significant positive change in economic growth without the economic contribution of other economic sectors.

Table 4. Long-run coefficients (Source: Authors' compilation)

| Variable | Coefficient | Std. error | t-Statistic | Prob. |
|---|---|---|---|---|
| lnTA | -0.331886 | 0.259852 | -1.277213 | 0.2128 |
| lnES | 1.510898 | 0.642396 | 2.351971 | 0.0265 |
| lnPG | 2.584021 | 0.846487 | 3.052641 | 0.0052 |
| C | -32.64969 | 16.96711 | -1.924293 | 0.0653 |

**4. Short-run coefficients**

In the short run, tourism development boosts economic growth (Table 5). As expected, the coefficient (0.041156) of tourism development is positive and statistically significant at 5% level of significance, suggesting that a 1% increase in tourism development leads to an increase of 0.041% in economic growth. An increase in tourism development promotes infrastructure development, attracts investment in tourism and other sectors, increases foreign income, and creates new jobs for local communities. The result is consistent with the tourism-led economic growth hypothesis. Previous studies found that tourism development positively influences economic growth (Liu & Wu, 2019; Muzekenyi et al., 2018). The short-run results also reveal that tourism development has positive lagged effects. The coefficients of tourism development in lag one (0.029043) and in lag two (0.013075) are statistically significant at 5% level. The result implies that the economy grows by 0.03% in the current year because of a 1% increase in tourism development in lag one (meaning the previous year).

The coefficient (0.495783) of electricity supply is significant at 5% level, meaning that the South African economy grows by 0.5% in the short run when the supply of electricity increases by 1%. This result is not surprising. Electricity is a

key driver of the economy in any country. A stable electricity supply is an important input in economic activities, including trading and manufacturing. This result corroborates the results of the previous study in South Africa, which found that the economy grows by 3.9% when the supply of electricity is increased by 1% (Khobai et al., 2016).

However, there was no evidence that population growth influences economic growth in the short run. Population growth may take a long time to influence economic growth. A study conducted in China also found that population growth had no effect on economic development in the short run (Yao & Liu, 2022). The current results also show that there is an error correction term (ECT) whose coefficient (-0.151912) has a negative sign as anticipated, and it is overwhelmingly statistically significant at 5% level. Consequently, the error correction model was employed to determine the period required every year for adjusting the disequilibrium. The coefficient of the error correction term suggests that approximately 15.2% of the disequilibrium is adjusted yearly, which is a relatively high rate. This suggests that only 6.58273 (1/0.151912) years (an estimate of six years and five months) are required for the disequilibrium to be corrected.

Table 5. Short-run coefficients (Source: Authors' compilation)

| Variable | Coefficient | Std. error | t-Statistic | Prob.* |
|---|---|---|---|---|
| Cointegrating equation | | | | |
| COINTEQ | -0.151912 | 0.016621 | -9.139779 | 0.0000 |
| Short-run regressors: Linear (Independent) | | | | |
| D(lnTA) | 0.041156 | 0.008433 | 4.880137 | 0.0001 |
| D(lnTA(-1)) | 0.029043 | 0.005754 | 5.047237 | 0.0000 |
| D(lnTA(-2)) | 0.013075 | 0.006234 | 2.097174 | 0.0463 |
| D(lnES) | 0.495783 | 0.081960 | 6.049111 | 0.0000 |
| R-squared | 0.836879 | Mean dependent var | | 0.021874 |
| Adjusted R-squared | 0.810779 | S.D. dependent var | | 0.024732 |
| S.E. of regression | 0.010758 | Akaike info criterion | | -6.075247 |
| Sum squared resid | 0.002894 | Schwarz criterion | | -5.841714 |
| Log likelihood | 96.12871 | Hannan-Quinn criter. | | -6.000538 |
| F-statistic | 32.06507 | Durbin-Watson stat | | 1.671810 |
| Prob(F-statistic) | 0.000000 | | | |

**5. Residual diagnostic and stability tests**

Different residual diagnostic tests were executed to determine whether the estimated ARDL model is correct and accurately represents the data. These diagnostic tests include normality, autocorrelation, and heteroscedasticity, where as the stability tests include the cumulative sum (CUSUM) and the cumulative sum of squares (CUSUMSQ). The normality test result (Table 6) affirms that the residuals are normally distributed. The p-value is 0.365956, which is greater than 0.05. Therefore, the null hypothesis was not rejected. The Breusch-Godfrey serial correlation LM test indicates that there is no autocorrelation in the residuals. The null hypothesis that there is no serial correlation was not rejected as the p-value (0.0739) is far above the threshold of 5% level. Based on the Heteroscedasticity test results; the null was not rejected because the p-value (0.1938) is not statistically significant at 5% (Table 7).

Table 6. Results of the normality test (Source: Authors' compilation)

| Series residuals | |
|---|---|
| Sample size | 1992 - 2021 |
| Observations | 30 |
| Mean | 4.03E-15 |
| Median | 0.000358 |
| Maximum | 0.016001 |
| Minimum | -0.028001 |
| Std. Dev. | 0.009989 |
| Skewness | -0.583812 |
| Jarque-Bera | 2.010487 |
| Probability | 0.365956 |

Table 7. Results of the Breusch-Godfrey test (Source: Authors' compilation)

| Breusch-Godfrey serial correlation LM test:Null hypothesis: No serial correlation at up to 2 lags | | | |
|---|---|---|---|
| F-statistic | 1.997059 | Prob. F(2,19) | 0.1632 |
| Obs*R-squared | 5.211052 | Prob. Chi-square(2) | 0.0739 |
| Heteroskedasticity Test: Breusch-Pagan-Godfrey; Null hypothesis: Homoskedasticity | | | |
| F-statistic | 1.550819 | Prob. F(8,21) | 0.1995 |
| Obs*R-squared | 11.14142 | Prob. Chi-square(8) | 0.1938 |
| Scaled explained SS | 6.810525 | Prob. Chi-square(8) | 0.5572 |

The stability tests show that CUSUM (Figure 2) and CUSUMSQ (Figure 3) remained within acceptable parameters during the sample period. This implies that there were no structural breaks or instability. The residual diagnostic and stability test results, therefore, confirm that the model used explains the data and that the results are valid.

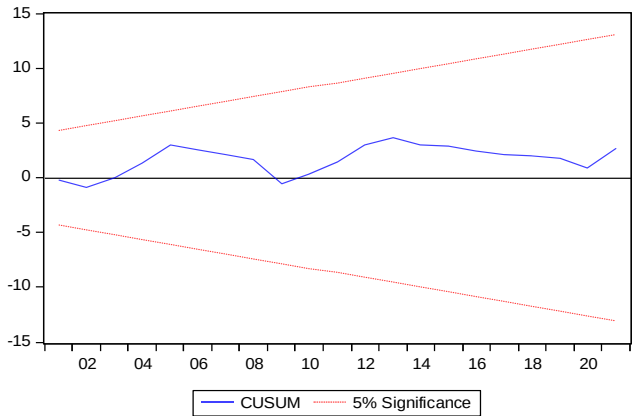


Figure 2. Result of the CUSUM test (Source: Authors' compilation)

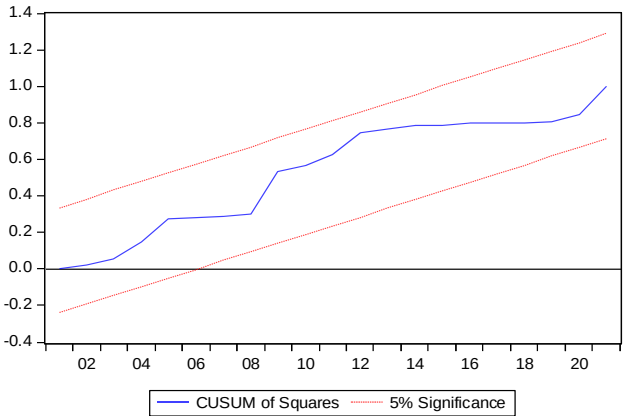


Figure 3. Result of the CUSUMSQ test (Source: Authors' compilation)

**6. Results of the paired Granger causality test**

Results of previous empirical studies show that tourism development and economic growth have a unidirectional causal relationship from tourism development to economic growth (Mishra et al., 2011). The current results (Table 8) show that South Africa's tourism development does not cause economic growth. The p-value (0.1426) is not statistically significant at 5% level. Instead, a unidirectional causal relationship was found from economic growth to tourism development, suggesting that economic growth promotes tourism development. It is not surprising that economic growth causes tourism development. When the economy grows, people's income and tourism investment increase, leading to tourism development. A country's economic growth is also considered by international tourists when choosing destinations. Tourists prefer to visit countries with strong economies (Santamaria & Filis, 2019). Liu et al. (2025) found that economic growth attracts tourists. The current finding is supported by previous studies, which found that economic growth triggers tourism development (Albaladejo et al., 2023; Bitok, 2020). In contrast, Cárdenas-García et al. (2024) found one-way causality from tourism to economic development, implying that tourism development causes positive economic growth.

A one-way causal relationship between economic growth and population growth was detected, and it flows from population growth to economic growth. This suggests that South Africa's population growth causes economic growth. Increasing population growth increases the consumption of produced goods and services, promoting more production of goods and services. Like this result (Suluk, 2021) also found that population growth and economic growth in Singapore had a unidirectional causal relationship running from population growth to economic growth. On the contrary, the current study found no evidence that South Africa's population growth is driven by economic growth, implying that population growth does not respond to changes in economic growth. The justification of this finding is that South Africa's stunted economic growth does not encourage South Africans to give birth because it may be difficult for them to raise the children. This result contradicts the results of previous studies (Cayssials et al., 2024; Mahmoudinia et al., 2020), which found a bidirectional relationship between population growth and economic growth. The result also opposes previous studies that have found a neutral causal relationship between population growth and economic growth (Karim & Amin, 2018). Like tourism development and population growth, electricity supply also has a unidirectional causal relationship with economic growth. This relationship is from electricity supply to economic growth, suggesting that a sufficient and uninterrupted supply of electricity instigates economic growth. However, it is surprising that economic growth does not trigger electricity supply. Economic growth means increased economic activities, which may also create increased demand for electricity. This result, however, is validated by many other studies that reported a one-way directional relationship from electricity supply to economic growth (Atchike et al., 2020; Dash et al., 2022; Mutumba et al., 2024). However, the result contradicts Aneja & Mathpal (2022), who found a two-way directional causal relationship between electricity supply and economic growth.

Table 8. Estimates of the paired Granger causality test Source: Authors' compilation

| Null hypothesis: | Obs | F-Statistic | Prob. |
|---|---|---|---|
| lnTA does not Granger cause lnGDP | 31 | 2.10080 | 0.1426 |
| lnGDP does not Granger cause lnTA | 10.4894 | 0.0005 | |
| lnPG does not Granger cause lnGDP | 31 | 3.92598 | 0.0324 |
| lnGDP does not Granger cause lnPG | 1.64551 | 0.2124 | |
| lnES does not Granger cause lnGDP | 31 | 5.38725 | 0.0110 |
| lnGDP does not Granger cause lnES | 2.74454 | 0.0829 | |

**CONCLUSION**

This study investigates the effects of tourism development, electricity supply, and population growth on economic growth in South Africa. The results show that an increase in electricity supply has positive effects in the long and short run. This highlights the importance of a steady and sufficient electricity supply in South Africa's economic growth. For the country to experience high and positive economic growth, it must generate and supply steady and sufficient electricity.

The influence of electricity supply on economic growth was also affirmed by the Granger causality test, which shows that electricity supply has a unidirectional causal relationship that runs to economic growth. These results support the

already established hypothesis that electricity supply stimulates economic growth. Population growth, on the other hand, affects economic growth only in the long run, and the effect is positive. It does not influence effect on economic growth in the short run, implying that any changes in population growth take time to cause an effect on economic growth.

Although an increase in population growth is good for the economy in the long run, uncontrolled population growth may hamper economic growth, especially when a large proportion of the population is economically inactive. The economically inactive population may be a burden to the economy. Tourism in South Africa is hailed for its massive contribution to the country's economy. Sometimes, tourism outperforms other economic sectors. Our results show that the effect of tourism development on economic growth is in the short run, not in the long run. The Granger causality test also shows that tourism development does not cause economic growth, but the unidirectional relationship is from economic growth to tourism development. For tourism development to influence economic growth, South Africa should improve its economy. Tourism makes a significant contribution to the economy when the economy and other economic sectors are performing well. The performance of the tourism sector relies on the performance of other sectors because it is not a stand-alone sector. There should be a two-way causal relationship between tourism development and economic growth.

The theoretical contribution is that the study provides insight into the effects of tourism development, population growth, and electricity supply on economic growth in South Africa. To the best of our knowledge, there are no studies that have investigated the effects of tourism development, electricity supply, and population growth on the economic growth in South Africa. Therefore, this study narrows this gap in the existing body of knowledge. Given that the electricity supply has positive effects on economic growth in the short and long run, the findings of this study may also galvanise the South African government to supply stable and sufficient electricity to boost its economic growth. This study, however, used international tourist arrivals as a proxy for tourism development, and electricity available for distribution in South Africa, generated by Eskom, as a proxy for electricity supply. Future studies may consider both international and domestic tourism. Studies may also consider including other types of energy such as natural gas and solar.

**Author contributions:** Conceptualization, J.C.M.methodology, J.C.M.software, J.C.M.validation, J.C.M.formal analysis, J.C.M.investigation, J.C.M.data curation, J.C.M.writing - original draft preparation, J.C.M.writing - review and editing, J.C.M.visualization, J.C.M.supervision, J.C.M.project administration, J.C.M. The author has read and agreed to the published version of the manuscript.

**Funding:** Not applicable.

**Institutional Review Board Statement:** Not applicable.

**Informed Consent Statement:** Not applicable.

**Data Availability Statement:** The data presented in this study may be obtained on request from the corresponding author.

**Acknowledgements:** The research undertaken was made possible by the equal scientific involvement of all the authors concerned.

**Conflicts of Interest:** The authors declare no conflict of interest.

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Article history: Received: 29.08.2025 Revised: 16.12.2025 Accepted: 10.03.2026 Available online: 06.04.2026