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Trade openness, carbon emission and poverty reduction dynamics in South Africa: A causality test

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- Poverty
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- South Africa

Abstract

The causal relationship between trade openness, carbon emission and poverty reduction in South Africa was examined using data from 1980 to 2023. The study was motivated by the high levels of poverty, carbon emission and trade openness existing in South Africa at the same time, despite policies implemented to reduce poverty and carbon emission and elevate sustainable trade. The primary objective of this study was to establish the causal relationship between carbon emission, poverty reduction and trade openness in South Africa. Employing autoregression distribution lag (ARDL) error correction-based causality approach, the study found a bidirectional causality between trade openness and poverty reduction; carbon emission and trade openness; and poverty reduction and carbon emission in the short run. In the long run, the study found a unidirectional causal relationship from poverty reduction to trade openness and from carbon emission to trade openness. Policy implications are discussed.

1. Introduction

South Africa is a signatory to the United Nations spearheaded Sustainable Development Goals (SDGs) where the country committed to reduce poverty among other goals by 2030. Alongside this commitment is the country's commitment to reduce the carbon footprint under the Paris Agreement. South Africa has demonstrated commitment by submitting the first Nationally Determined Contribution (NDC) in 2016 and a revised target in 2021 of 398 -510 MtCo2e by 2025 and 350-420 MtCO2e by 2030 (NDC Partnership, 2025). The country has taken a bold step and further commitment to net zero emission by 2050 (NDC Partnership, 2025). South Africa is ranked among high polluting countries in the world, mainly because of the country's reliance on coal in electricity generation (Development Bank of Southern Africa 'DBSA', 2025). This puts a lot of pressure on the government to craft policies that are aligned to the agreements signed and advance social economic development including poverty reduction. Poverty reduction has remained a challenge in South Africa among the triple challenges identified in the National Development Plan (NDP) 2030. The call for a reduction in the carbon footprint and SDGs commitments is taking place during a time when economic integration has become a norm to advance economic development goals. South Africa is part of the World Trade Organisation (WTO) that oversee international trade by setting rules, provide a dispute resolution platform and provide a platform for countries to negotiate trade terms among other roles (WTO, 2025). The WTO encourages countries to engage in trade to improve living standards of people in member countries (WTO, 2025). This study, therefore, investigated the causal relationship among trade, carbon emission and poverty reduction in South Africa. The results from this study provide an insight on which policies should get priority to trigger a boomerang effect on other variables to meet the commitment made under the SDGs and the Paris Agreement.

The extant literature on the causal relationship between trade and poverty and carbon emission is inconclusive (see, for example Awad and Warsame (2022); Rahman, et al., 2022), making generalisation of these results inappropriate for policy formulation to a country like South Africa where carbon emission, trade and poverty reduction are critical to advancing economic development. The findings from this study will provide policy guidance on which variable to influence first to get desired response in the other variables of interest for South Africa.

The study employs ARDL- error correction-based causality approach to examine the causal relationship between trade openness, carbon emission and poverty reduction. The ARDL error-correction-based causality approach provides several advantages, for example, the causal results are broken down into immediate and delated response – short and long run (Pesaran, Shin and Smith, 2001). The approach provides robust results in small samples. South Africa was selected as a country of study because the country is among emerging economies still grappling with high poverty levels, carbon emission and yet, has made great effort to integrate into the global economy by opening the trade and the financial sector.

The rest of the study is structure as follows: Section 2 outlines country-based literature and empirical literature; section 3 dwells on the materials and methods and section 4 covers discussion of results. Section 5 concludes the study.

2. Literature review

2.1 Trade, poverty and carbon emission dynamics in South Africa

South Africa's trade is guided by the Trade Policy which provides a framework for trade. The major policy trust are export-led growth and diversification of markets for South African goods and services; industrial development with bias toward value addition; negotiation of trade agreements; protection of domestic industries through a delicate balance between liberalisation and domestic industry protection; and to ensure inclusivity and sustainable growth. South Africa has made great strides in liberalisation of trade since the end of the apartheid (Stern and Ramkolowan, 2021; Cassim et al. 2004). The end of apartheid also marked a gradual transition from a protectionist regime to an outward looking trade policy. The liberalisation was characterised by reduction or removal of trade tariffs, entering into trade agreements in different capacities- multilateral trade agreements, regional trade agreements and bilateral trade agreements (the dtic, 2025). For example, South Africa is a member of the Southern African Customs Union (SACU) which entered into force in 2004 through the SACU Agreement. Member countries in the SACU negotiate trade agreements as a bloc (the dtic, 2025). Through the Department of Trade, Industry Competition, South Africa advances trade in Africa through promotion of cross border infrastructure development; negotiate agreements on investment protection and economic cooperation; promote two-way trade; and identification and establishment of joint investment partners and promotion of regional integration.

To the rest of the world, The Department of Trade, Industry and Competition pursues bilateral and regional trade negotiations. This endeavour resulted in trade agreements like the Preferential trade agreement (PTA) with MERCOSUR, bilateral economic relations with the European Union (EU); Africa Growth and Opportunity Act (AGOA) with the United States, BRICS and the AfCFTA among other trade agreements (the dtic, 2025). Non-quantitative restrictions were also removed to facilitate trade. These include administrative processes like licensing and export license requirements (the dtic, 2025). The Internation Trade Administration Commission of South Africa (ITAC) aims to create a fair trade through administration of trade instruments and providing technical support to the Department of Trade, Industry and Competition (ITAC, 2025).

On the poverty front, the government inherited a highly unequal and impoverished population after the end of apartheid. The policies pursued after gaining independence focused on redressing inequalities that existing during apartheid where some social classes we favoured against other classes, causing a divide between the classes forming one of the sources of poverty. The Reconstruction and Development Programme pursued from 1994 to 1996 focused on access to social services and creation of jobs (Corder, 1997). The successor programmes continued with attracting investment, trade liberalisation and macroeconomic stability that was believed to improve living standards and boost economic growth. National development programmes like the Accelerated and Shared Growth Initiative for South Africa (ASGISA) and the National development Plan (NDP) focused on poverty reduction and economic growth, employment reaction and reduction in inequality (National Planning Commission, 2025). The approach to poverty reduction in South Africa can be categorised into three.

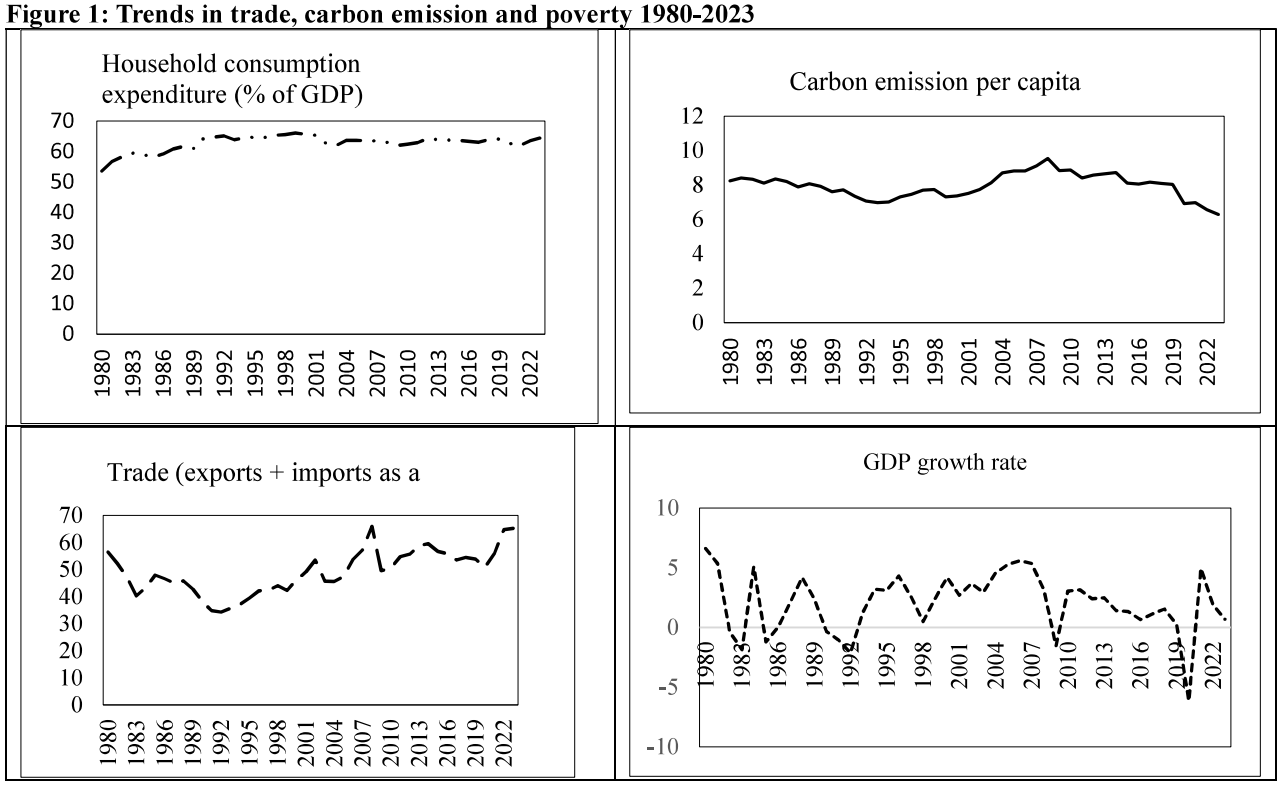
Firstly, is creation of immediate relief to the poor through a social safety net that caters for different categories of the population. For example, South Africa provides Child Support Grant, Disability Grant, Foster Care Grant, Old Age Grant, Care Dependency Grant and the War Veterans Grant and the Social Relief Distress (SRD). The SRD was availed in response to economic impact of the COVID-19 on most families that lost breadwinners and lost employment, or their businesses went bankrupt. This shows how responsiveness of the South African government to economic needs of the population and foster decent living standard for everyone.

Secondly, the government focuses on breaking the vicious cycle of poverty through provision of means for impoverished families to be able to generate income for themselves in the future. The government provides social services like education, housing and health to the vulnerable population. Thirdly, government has availed programmes that ensure the poor and previously disadvantaged are integrated into the main economic stream. Government provides financial support through the Department of Trade, Industry and Competition to small businesses. The Expanded Public

Works is also an outfit created to provide employment opportunities to the less advantaged and a platform for them to gain experience which would help them to be absorbed in formal employment. The Broad Black Economic Empowerment (BBEE) and Affirmative Action are some of the programmes that were rolled to support previously disadvantage population so that they are integrated in the main economic stream. These programmes have managed to support the previous underprivileged, although more still needs to be done to reach out to the needy.

On carbon emission, South Africa is among the top carbon emitters in the world and the worst emitter in Africa mainly due to reliance on coal in electricity generation (DBSA, 2025). South Africa is one of the signatories to the Paris Agreement that focuses on reduction in greenhouse gas emission and encourage signatories to pledge to reduce carbon emission which is responsible for climatic changes. South Africa is committed to carbon emission reduction expressed in the Nationally Determined Contribution (NDC). The NDC is a national commitment that is submitted to United National Framework Convention on Climate Change (UNFCC) secretariat. Even before signing the Paris Agreement, South Africa was already taking steps to reduce carbon emission. In 2011, South Africa drafted the National Climate Change Policy that provides a framework for reduction in greenhouse gas (GHG) emission and focus on a trajectory were emission would reach a peak before declining. The commitment to carbon emission reduction culminated in the Carbon Tax Act of 2019 and the Climate Bill signed into effect in 2024. The legislative framework allows the government to effectively put measures to reduce carbon emission. Given the large portion of carbon emission is associated with coal fired electricity generating plants, the Integrated Resource Plan (IRP) and the Just Energy Transition (JET) are some of the efforts government has put towards ensuring an electricity mix that moves toward cleaner energy and at the same time protect jobs and communities that depend on coal. Through the JET South Africa also managed to get pledges from developed countries who are willing to fund the transition from coal generated electricity to cleaner energy. Figure 1 exhibits trends in trade, poverty and carbon emission dynamics 1980 to 2023.

Figure 1: Trends in trade, carbon emission and poverty 1980-2023



Source: World Bank (2025)

Household consumption expenditure consistently increased during the study period, suggesting an improvement in poverty levels in South Africa from 1980 to 2023 (World Bank, 2025). Trade picked a gradual upward trend from 1992, although characterised by fluctuations. This confirms that South African's trade policy and emphasis on joining other countries in globalisation paid off by stimulating trade (World Bank, 2025). The same cannot be said on carbon emission which took a downward trend from 1980 to 1992 before taking an upward trend until 2008 where another decline was recorded until 2023 (World Bank, 2025). Trends in carbon emission reflects initial increase in carbon emission due to revitalisation of the manufacturing sector and late government's initiative to balance industrial advancement and decreasing carbon emission. This was a response to the United Nations call for countries to take action

to reduce carbon emission, one of the culprits responsible for climate change. Economic growth remained sluggish throughout the study period with an average growth rate of 2% (World Bank, 2025).

2.2 Empirical literature review

The interconnections among trade, carbon emissions, and poverty are complex. Trade liberalisation has the potential to stimulate economic growth and alleviate poverty by generating employment opportunities and increasing income, particularly in labour-abundant economies such as South Africa. However, it may also contribute to increased carbon emissions due to industrial expansion and lax environmental regulation, as outlined by the Pollution Haven and Environmental Kuznets Curve hypotheses. Environmental degradation can subsequently worsen poverty by adversely affecting health, diminishing productivity, and depleting natural resources. The ultimate outcome is determined by the interplay of economic growth, environmental policy frameworks, and institutional strength, which together influence whether trade advances sustainable and inclusive development or not. There are limited studies that have explored the causal relationship among poverty, trade and carbon emission in one study and among studies that have examined causal relationship between any two of the variables at a time, impact studies are also reviewed to provide an insight on the relationship between the three variables.

Poverty and trade

Balogun, et al. (2024) studied the causal relationship between trade openness, poverty, and sustainable development for Economic Community of West African States (ECOWAS) using data from 1986 to 2020. Using Dumitrescu-Hurlin panel causality test, the study found unidirectional causal relationship between trade openness and sustainable development. Rahman, et al. (2022) investigated the causal relationship between poverty and trade for Brazil, Russia, India, China, South Africa (BRICS) countries. The study found poverty to cause trade. Among the studies that have examined the impact of trade on poverty or the impact of poverty on trade, Nesssa and Imai (2022) in a study on the impact of trade openness on working poverty, for 98 developing countries using data from 2000-2016, found trade openness to reduce working poverty. Ullah et al. (2022) in a study for Pakistan on the association between poverty, trade and natural gas using data from 1990 to 2018. Using simultaneous equation method for data analysis, the study found trade liberalisation to reduce poverty through increasing industrial production as a mediating factor. Adegboyo et al. (2021) found globalisation to reduce poverty in a study on Nigeria using data from 1985 to 2020 and autoregressive distributed lag approach. Anderson (2020) found trade liberalisation to reduce poverty in developing countries. Kelbore, (2015) studied the effects of trade openness on poverty reduction and structural transformation for 43 African countries using data from 1981 to 2010. Employing a system generalised method of moments (GMM), the study found trade openness to worsen poverty initially by 1.3% and reduce poverty by 1.2% in one period.

Trade and carbon emission

Wang, Li and Ge (2025) in a study on China on carbon emission transfer and trade policy, using the bootstrap rolling-window approach, the study found a bidirectional causality between carbon emission and trade. Balogun et al. (2024) examined the causality between trade openness and poverty for the Economic Community of West African States (ECOWAS) using Dumitrescu-Hurlin panel causality test and data from 1987- 2020. The study found a unidirectional causal relationship from poverty alleviation to sustainability. Among the impact studies, Chen, Jiang and Kitila (2021) on a study for 64 countries along the Belt and Road using data from 2001 to 2019. The study found a positive effect of trade openness on carbon emission. The study also found an indirect impact of trade openness on carbon emission through economic growth to be positive.

Poverty and carbon emission

Among the studies that examined the causal relationship between poverty and carbon emission, Khan (2024) investigated the causal relationship between poverty, environmental degradation and unemployment for 10 developing countries in Asia using data from 1997-2021. Using panel fully modified ordinary least square (FMOLS) and panel Granger-causality test the study found poverty to contribute to environmental deterioration. The causality results revealed a bidirectional causal relationship between poverty and environmental degradation. Awad and Warsame (2022), examined the causal relationship between poverty and environmental quality for 91 developing countries using data from 1990 to 2015. Using heterogeneous panel causality analysis, the study found bidirectional causality between poverty and ecological footprint – a measure of environmental quality for the global panel and African region. No causality was confirmed for developing countries in Latin America, Caribbeans regions and Asia.

On impact studies, Baloch et al. (2020) examined the linkage between poverty, environmental degradation and income inequality for 40 sub-Saharan Africa countries using data from 2010 to 2016. The study found that an increase

in poverty has a negative impact on the environment. Khan (2019) studied the nexus between carbon emission and poverty for a panel of Association of Southeast Asian Nations (ASEAN) states using data from 2007 to 2017. Employing GMM the study found a positive relationship between poverty and environmental degradation.

Although the causal studies reviewed among trade, poverty and carbon emission are limited, the results point to a variation in the results depending on the country under study and the methodology employed. Lack of consistence in the results reviewed confirm the importance of another study that examines the nature of the relationship for South Africa using ARDL-ECM based causality approach. The findings from this study provide policy guidance on trade, poverty and carbon emission endeavours.

3. Methodology

The study employs ARDL-error based Granger causality analysis to examine the causal relations between trade openness, carbon emission and poverty reduction. The approach was selected because of a number of advantages. For example, the approach does not require all the variables in the model to be integrated of the same order and the results from the analysis are broken into short run and long run time frames (Pesaran et al. 2001). This provides an advantage when policy formulation targets immediate relieve and long-term stability. The causal relationship is carried out in a multivariate causality framework to avoid biased results from bivariate causality framework.

3.1 Variables

The model includes three primary variables: carbon emission (CE) captured by carbon emission per capita, poverty reduction (POV) captured by household consumption expenditure per capital growth rate and trade openness (TRADE) captured by a sum of exports and imports as a percentage of GDP. To minimise omission of variable biased, an intermittent variable - GDP growth rate (GDPGR) was included in the model to form a multivariate framework. The GDPGR was included as an intermittent variable because it has great influence on the variables of interest - carbon emission, poverty and trade openness.

3.2 The autoregressive distributed lad (ARDL) model specification

Variables included in the ARDL specification (CE, POV, TRADE, GDPGR) given in Equation 1-4.

$$\Delta CE_t = \alpha_0 + \sum_{i=1}^{p} \alpha_{1i}\,\Delta CE_{t-i} + \sum_{i=0}^{q} \alpha_{2i}\Delta\, POV_{t-i} + \sum_{i=0}^{q} \alpha_{3i}\,\Delta TRADE_{t-i} + \sum_{i=0}^{q} \alpha_{4i}\,\Delta GDPGR_{t-i} + \theta_1 CE_{t-1} + \theta_2 POV_{t-1} + \theta_3 TRADE_{t-1} + \theta_4 GDPGR_{t-1} + \mu_{1t} \quad \ldots(1)$$

$$\Delta POV_t = \alpha_0 + \sum_{i=0}^{q} \alpha_{1i}\,\Delta CE_{t-i} + \sum_{i=1}^{p} \alpha_{2i}\Delta\, POV_{t-i} + \sum_{i=0}^{q} \alpha_{3i}\,\Delta TRADE_{t-i} + \sum_{i=0}^{q} \alpha_{4i}\,\Delta GDPGR_{t-i} + \theta_1 CE_{t-1} + \theta_2 POV_{t-1} + \theta_3 TRADE_{t-1} + \theta_4 GDPGR_{t-1} + \mu_{2t} \quad \ldots(2)$$

$$\Delta TRADE_t = \alpha_0 + \sum_{i=1}^{q} \alpha_{1i}\,\Delta CE_{t-i} + \sum_{i=0}^{q} \alpha_{2i}\Delta\, POV_{t-i} + \sum_{i=1}^{P} \alpha_{3i}\,\Delta TRADE_{t-i} + \sum_{i=0}^{q} \alpha_{4i}\,\Delta GDPGR_{t-i} + \theta_1 CE_{t-1} + \theta_2 POV_{t-1} + \theta_3 TRADE_{t-1} + \theta_4 GDPGR_{t-1} + \mu_{3t} \quad \ldots(3)$$

$$\Delta GDPGR_t = \alpha_0 + \sum_{i=1}^{q} \alpha_{1i}\,\Delta CE_{t-i} + \sum_{i=0}^{q} \alpha_{2i}\Delta\, POV_{t-i} + \sum_{i=1}^{P} \alpha_{3i}\,\Delta TRADE_{t-i} + \sum_{i=0}^{q} \alpha_{4i}\,\Delta GDPGR_{t-i} + \theta_1 CE_{t-1} + \theta_2 POV_{t-1} + \theta_3 TRADE_{t-1} + \theta_4 GDPGR_{t-1} + \mu_{4t} \quad \ldots(4)$$

Where:
CE = carbon emission per capita
POV= poverty captured by household consumption expenditure
TRADE = trade openness captured by a sum of imports and export as a percentage of GDP
GDPGR = Gross domestic product (GDP) growth rate
α_0 is a constant; $\alpha_1 - \alpha_4$; $\theta_1 - \theta_4$ are coefficients; and $\mu_1 - \mu_4$ are error terms.
The ECM - model specification for Equation 1-4 is given in Equation 5-8.

$$\Delta CE_t = \alpha_0 + \sum_{i=1}^{p} \alpha_{1i}\,\Delta CE_{t-i} + \sum_{i=0}^{q} \alpha_{2i}\Delta\, POV_{t-i} + \sum_{i=0}^{q} \alpha_{3i}\,\Delta TRADE_{t-i} + \sum_{i=0}^{q} \alpha_{4i}\,GDPGR_{t-i} + \varepsilon_1 ECM_{t-1} + \mu_{1t} \quad \ldots(5)$$

$$\Delta POV_t = \alpha_0 + \sum_{i=1}^{q} \alpha_{1i}\,\Delta CE_{t-i} + \sum_{i=0}^{p} \alpha_{2i}\Delta\, POV_{t-i} + \sum_{i=0}^{q} \alpha_{3i}\,\Delta TRADE_{t-i} + \sum_{i=0}^{q} \alpha_{4i}\, GDPGR_{t-i} + \varepsilon_1 ECM_{t-1} + \mu_{2t} \quad (6)$$

$$\Delta TRADE_t = \alpha_0 + \sum_{i=1}^{q} \alpha_{1i}\,\Delta CE_{t-i} + \sum_{i=0}^{q} \alpha_{2i}\Delta\, POV_{t-i} + \sum_{i=0}^{p} \alpha_{3i}\,\Delta TRADE_{t-i} + \sum_{i=0}^{q} \alpha_{4i}\, GDPGR_{t-i} + \varepsilon_1 ECM_{t-1} + \mu_{3t} \quad (7)$$

$$\Delta GDPGR_t = \alpha_0 + \sum_{i=1}^{q} \alpha_{1i}\,\Delta CE_{t-i} + \sum_{i=0}^{q} \alpha_{2i}\Delta\, POV_{t-i} + \sum_{i=0}^{q} \alpha_{3i}\,\Delta TRADE_{t-i} + \sum_{i=0}^{P} \alpha_{4i}\, GDPGR_{t-i} + \varepsilon_1 ECM_{t-1} + \mu_{4t} \quad (8)$$

Where ECM= error correction model
$\mu_1 - \mu_4$ are error correction coefficients.
$\varepsilon_1 - \varepsilon_4$ are coefficients for the ECM.

3.3 Discussion of results

To avoid spurious regression, a stationarity test was done using the Augmented Dickey Fuller (ADF) and the Phillip-Perron (PP). The results of the unit root test are presented in Table 1.

Table 1: Unit root test results

	Augmented Dickey Fuller (ADF)		Phillips-Perron (PP)	
Variable	Level	Δ	Level	Δ
CE	0.940085	-6.442865***	-1.115365	-6.445036***
HCE	-1.537845	-6.592863***	-1.393811	-7.650881***
TRADE	-1.544260	-6.926109***	-1.541196	-7.526288***
GDPGR	-0.992736	-5.127708***	-0.970334	-5.128146***

Note: *, ** and *** denote stationarity at 10%, 5% and 1% significance levels, respectively.

The results reported in Table 1 confirmed that all the variables in the model are stationary in first difference. To proceed with the analysis, a long run relationship among the variables included in the functions was tested. The functions where cointegration was not confirmed, estimation was done for the short run causality, while for the functions where cointegration was confirmed, causality was done for the long run and the short run timeframes. The results of the cointegration test are reported in Table 2.

Table 2: Cointegration results

Dependent variable	**Function**		**F-statistic**		**Cointegration status**	
Model 1: Tourism proxied by tourism receipts (TR)						
CE	F (CE|POV, TRADE, GDPGR)		1.854607		Not Cointegrated	
POV	F (POV|CE, TRADE, GDPGR)		0.834543		Not Cointegrated	
TRADE	F (TRADE|CE, POV, GDPGR)		4.756238**		Cointegrated	
GDPGR	F (GDPGR|CE, POV, TRADE)		2.288058		Not Cointegrated	
Critical values	10%		5%		1%	
	I (0)	I (1)	I (0)	I (1)	I (0)	I (1)
	2.538	3.398	3.048	4.002	4.188	5.328

Note: *, ** and *** denote stationarity at 10%, 5% and 1% significance levels, respectively.

The results presented in Table 2 confirmed cointegration in the following function F (TRADE|CE, POV, GDPGR), implying that causality test will be done for both the short and the long run periods. The rest of the functions where no cointegration was confirmed, estimation is only done for the short run. The ECM-based causality test results are reported in Table 3.

Table 3: Causality results

Variable					
	t-stat [p-value]				**ECM (F-stat)**
	ΔCE	ΔPOV	ΔTRADE	ΔGDPGR	
ΔCE	-	2.8064* [0.071]	3.199* [0.081]	10.935*** [0.000]	-
ΔPOV	0.3.990** [0.025]	-	6.641** [0.003]	9.739*** [0.000]	-
ΔTRADE	9.155*** 0.004]	2.893* [0.096]	-	10.015*** [0.000]	-0.489** [-4.443]
ΔGDPGR	10.648*** [0.0002]	1.664 [0.2001]	9.167*** [0.0005]	-	-

Note: *, ** and *** denote stationarity at 10%, 5% and 1% significance levels, respectively.

Results presented in Table 4 confirmed a bidirectional causality between trade openness and poverty reduction in the short run and a unidirectional causal relationship from poverty reduction to trade openness in the long run. The results confirmed a mutual reinforcing effect between trade and poverty reduction, implying that policies that reduce poverty stimulate more trade which consequently lead to lower poverty levels. Another bidirectional causality was found between carbon emission and trade openness in the short run and a unidirectional causal relationship from carbon emission to trade openness in the long run. According to the findings of the study, trade openness and carbon emission have a mutual reinforcing effect in the short run, while in the long run carbon emission stimulate more trade. The study also found a bidirectional causality between poverty reduction and carbon emission in the short run. These results are not unique to South Africa alone, Khan (2024) and Awad and Warsame (2022), (2022) found the same results for developing countries.

Other results presented in Table 4 revealed a bidirectional causality between trade openness and GDP growth in the short run and a unidirectional causal relationship from GDP growth rate to trade openness in the long run. This confirms the mutual reinforcing effect between GDP and trade openness in the short run and the long-term influence of GDP on trade. The study also found a unidirectional causal relationship from GDP growth rate to poverty reduction in the short run. The results confirmed an important role played by the growth in GDP in the provision of resources required to drive poverty reduction programmes. The study also found a bidirectional causality between GDP growth rate and carbon emission in the short run. Thus, GDP growth rate and carbon emission have a mutual reinforcing effect, suggesting in increase in GDP growth influence carbon emission positively, while the increase in carbon emission directly relates to an increase in GDP.

4. Conclusion

The causality between carbon emission, poverty reduction and trade openness was examined for South Africa using data from 1970 to 2023. The study was motivated by the high levels of poverty, carbon emission and trade openness existing in South Africa at the same time, despite policies implemented to reduce poverty and carbon emission and increase trade. Employing ECM-based causality test, the study found a bidirectional causality between trade openness and poverty reduction; carbon emission and trade openness; and poverty reduction and carbon emission in the short run. In the long run, the study found a unidirectional causal relationship from poverty reduction to trade openness and carbon emission to trade openness. Based on the findings of the study it can be concluded that poverty reduction has a mutual reinforcing effect on trade openness and carbon emission in the short run, while in the long run poverty reduction and carbon emission influenced trade openness. Carbon emission and trade openness influence each other in the short run, while the long run relationship is dominated by carbon emission. It is recommended that South Africa's policy makers continue with programmes that alleviate poverty such as integration of the poor into the economic mainstream, creation of jobs as a long-term measure and social safety net expansion for short term relief to influence trade openness. The thrust by the South African government on the green industrialisation aligns with economic growth and trade expansion that promote environment sustainability remain crucial. Although all effort has been made to ensure the scientific rigour of

the study, a few limitations were encountered. For example, the study used household consumption expenditure per capita growth as a measure of poverty reduction, this proxy captures income poverty, future studies can benefit from other measures of poverty reduction. The study used GDP growth rate as an intermittent variable, future studies can explore other intermittent variables like financial development in a multivariate causality framework.

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