AN ASSESSMENT OF THE IMPACT OF NATURAL RESOURCE RENT, FINANCIAL DEVELOPMENT AND URBANIZATION ON CARBON DIOXIDE EMISSIONS: THE CASE OF TÜRKİYE AND SOUTH AFRICA

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Abstract: Türkiye and South Africa are the most globalized, urbanized and the most carbon-intensive economy in the emerging economies. In this direction, this study examines an assessment of the impact of natural resource rent, financial development, and urbanization on carbon dioxide emissions in South Africa and Türkiye. For the period 1990-2021, we have implemented an Auto-Regressive Distributed Latency (ARDL). The ARDL cointegration test result shows the existence of a long-term relationship between the variables. The granger causality test indicates that there is a bi directional relationship between carbon dioxide emissions and natural gas rents, financial development and natural gas rent and urbanization and natural gas rent. In addition to, this VAR Granger Causality/Block Exogeneity Wald Tests shows that there is a link between carbon dioxide emissions and financial development.

Key words*:* CO_2 emissions; Financial development; Natural resource rent; Natural gas rent; Urbanization; Autoregressive distributed lag model

JEL Classification Codes: O1, Q26, Q53, R51.

1. INTRODUCTION

Environmental degradation and climate change pose serious threats to human life on a world scale, thus become a growing threat to the world. As a result of this increasing outcome, countries are under great pressure to realize sustainable development, for the general welfare.

The Intergovernmental Panel on Climate Change (IPCC, 2023) According to the findings highlighted in the report, there is no doubt that anthropogenic emissions from our dependence on fossil fuels are harming the planet. Human activities have certainly caused global warming, and the global surface temperature rose 1.1°C above industrial temperatures between 2011 and 2020.

In recent years, the world is facing a significant increase in urbanization, developing countries is facing more urban migration due to the climate change. Many scholar's research focuses on emerging economies, however, none of these studies have investigated and compared only these two developed countries, Türkiye and South Africa.

There are many articles that have been written on natural resource rent, financial development, and urbanization on carbon dioxide emissions, examining both countries individually, and this article wants to focus on comparing those aspects of these two countries. Some of these articles are summarized below. (Ozturk & Acaravci, 2013) examines the links between carbon emissions, energy consumption, trade, economic growth, and financial development in Turkey between 1960 and 2007. The findings show that an increase in the ratio of international trade to GDP causes an increase in per capita carbon emissions, and that over the long term, the financial development variable has no discernible impact on per capita carbon emissions. The applicability of the EKC hypothesis to the Turkish economy is further supported by these findings. This means that the level of CO_2 emissions in Turkey, first rises with income, reaches an equilibrium point, and begins to decline. (Shahbaz et al., 2013) this research studies the impact of financial development, economic growth, coal use, and trade openness on environmental performance. Using annual data for the South African economy from 1965 to 2008. The long-run relationship between variables was tested using the ARDL limits test approach. While the short-range dynamics were investigated using the error-corrected method (ECM).

The authors results supported long-term relationships between the variables. The results show that while financial development reduces carbon emissions, economic growth increases them.

The remaining sections of this paper are as follows: The second section reviews the literature review. The third section represents the data source and some descriptive statistics. In the fourth section, the results and findings are discussed.

2. LITERATURE REVIEW

2.1. Natural Resource Rent and Carbon Dioxide Emissions

Natural resource rent and carbon emissions are two interconnected concepts related to the use of natural resources and their impact on the environment. Here are some articles related to the effects financial development on carbon dioxide emissions. (Li et al., 2022) the authors of this study focus on the Emerging Economies between 2000 and 2020, by demonstrating that natural resource rent has a detrimental effect on financial growth. On the other hand, financial development is positively impacted by investments in human capital. It has also been demonstrated that trade openness in the Emerging E-15 economies fosters economic expansion.

This study suggests an increase in the need for various resources and efficiency in order to make better use of the natural resources in the banking industry. To make the most of natural resources, The financial sector should receive more attention than the non-financial sector in order to optimize natural resources. (Huang et al. 2021) this article aims to examine the long and short-term relationship between natural resource rent, financial development, and urbanization on carbon emission from the context of the USA between 1995–2015. Using the quantile autoregressive distributed lagged model (QARDL) With the aid of a cutting-edge and ground-breaking Because non-linearity is noted for the study variables. The results showed that, during long-term estimation in the specified quantiles of the study, higher levels of urbanization (0.489), natural resource rent (0.102), and financial development (0.304) have a impact on environmental degradation in the USA. This shows that increased urbanization, financial development, and the exploitation of natural resources are putting greater environmental pressure on the US economy.

Bekun et al., (2019) empirical analysis examines how energy use and the NRR affect South Africa's carbon emissions. The results of the study demonstrate a long-term relationship between pollutant emission and overall NRR in the South African economy. Zaidi, S. A. H., et al. (2019) applies a series of second-generation econometric tools to address the problem of cross-sectional dependence and heterogeneity in panel data. The study covers data from 1990 to 2016. The outcomes of the cointegration method suggest a long-term link between the variables. Globalization, natural resources, and human capital have a positive and significant impact on financial development, according to empirical findings from the Continuously Updated Fully Modified (Cup-FM) ordinary least squares approach. Gross fixed capital formation and economic expansion positively effect financial development. The results show that globalization, economic expansion, and gross fixed capital formation have a positive impact on the dependent variable, or financial development. Natural resources positively effect financial development, while financial growth positively effect human capital.

2.2. Financial Development and Carbon Dioxide Emissions

There are many aspects to the relationship between financial development and carbon dioxide emissions. Financial development provides opportunities to finance technical developments and activities that may help reduce carbon emissions, although it can initially lead to increased carbon emissions due to economic growth and investment in carbon-intensive sectors.

The path of carbon dioxide emissions in the context of financial development can be further influenced by effective environmental regulations and the increased emphasis on sustainability and green finance. Here are some articles related to the effects financial development on carbon dioxide emissions. (Adabor, 2023) reveals how financial development affects for gas resource rent. The author found that financial development has a positive and large impact on gas resource rent, using two alternative time series techniques, indicating that an effective financial system or market encourages the extraction of natural gas resources. The author used the Autoregressive Distributed Lag Models (ARDL), and proposes the net domestic credit per GDP and monetary sector credit to the private sector per GDP have a positive and significant impact on gas resource rent. Both the narrow money supply and the broad money supply have a marginally positive but insignificant effect on gas resource rent. (Sekali & Bouzahzah, 2019) uses time series data from 1980 to 2015 and ARDL modelling (Autoregressive Distributive Lag Model) to examine the impact of financial development on environmental quality in Morocco. The model shows that there is a relationship between financial development and CO_2 emissions, but this is not statistically significant.

Ali et al. (2019) explores at the dynamic effects of Nigeria's financial development, energy use, trade openness, and economic growth on CO_2 emissions. For the years 1971–2010, Authors used the autoregressive distributed lag bound testing technique. The empirical findings show that the variables have a long-run cointegration relationship. However, the long-run estimation result shows that trade openness has a negative and large impact on carbon dioxide emissions while economic growth, financial sector expansion, and energy consumption have positive and significant impacts.

Shahbaz et al. (2013) in the case of Malaysia, this study analysis whether financial development reduces CO_2 emissions. To achieve this, authors verify the cointegration between the variables using the bounds test method. The findings show that CO_2 emissions, financial development, energy consumption, and economic growth are interrelated in the long term. In addition, empirical data show that financial development reduces CO_2 emissions. The Granger causality study reveals the feedback hypothesis between energy consumption and CO_2 emissions, between CO_2 emissions and economic growth, and between financial development and CO_2 emissions.

Shahbaz et al. (2013) tested the link between energy consumption, economic growth, financial development on CO_2 emissions over the period 1975Q_1-2011 Q_4 the case of Indonesia. Authors result confirms that variables are integrated and there is long run relationship between the variables. Experimental results indicate that economic growth to increase energy consumption increases carbon dioxide emissions, while financial development and trade openness VECM causal analysis showed a feedback hypothesis between energy consumption and emissions carbon dioxide emissions. Economic growth and of CO_2 emissions also interrelated, and the financial development granger causes CO_2 emissions.

Sadorsky, P. (2010) investigated the impact of financial development on energy consumption in a sample of emerging countries using generalized method of moments estimating techniques.

Using a panel dataset of 22 developing countries for the period 1990–2006. The empirical findings show that there is a positive and statistically significant relationship between financial development and energy consumption when measuring financial development using stock market variables like stock market capitalization to GDP, stock market value traded to GDP, and stock market turnover.

2.3. Urbanization and Carbon Dioxide Emissions

Urbanization and carbon emissions are closely linked, and urbanization itself can have a big impact on greenhouse gas emissions, particularly carbon dioxide (CO_2) emissions. Here are some articles related to the effects urbanization on carbon dioxide emissions.

Abbasi et al. (2020) aims to examine the effects of urbanization and energy use on carbon dioxide (CO_2) emissions for a panel of 8 Asian nations from 1982 to 2017 (Pakistan, Bangladesh, China, India, Indonesia, Malaysia, Sri Lanka, and Nepal). According to the primary findings of panel co-integration. Panel co-integration and Granger causality techniques were applied in the analyses. Urbanization, energy use, and CO_2 emissions are all linked over time. The findings also show that urban growth and high energy use have a positive and significant impact on CO_2 emissions, which hinder to long-term improvements in environmental quality. The results also show that there is a bidirectional causality relationship between energy use and urbanization, and a unidirectional relationship between energy use and CO_2 emissions.

Dogan and Turkekul (2016) the purpose of this study is to examine the relationships between the following variables: carbon dioxide (CO_2) emissions, energy consumption, real output (GDP), GDP2 (square of real output), trade openness, urbanization, and financial development, in the USA from the period 1960 to 2010. According to the Granger causality test results, there is no causal relationship between CO_2 and trade openness or gas emissions and financial development, but there is a bidirectional relationship between CO_2 and GDP, energy consumption, urbanization, and GDP. Additionally, there is sufficient data to demonstrate a one-way causal relationship between GDP to energy consumption, financial development to output, and from urbanization to financial development. (Sun et al., 2020) Authors used the Common Correlated Effect Mean Group (CCEMG) and Augmented Mean Group (AMG) methods from 1992-2015 OECD with B&R countries. The result shows that other factors such as trade openness, urbanization, and energy usage have been responsible for the recent increase in carbon emissions in the worldwide.

Table 1. Summary of Studies on Financial Development Emissions CO_2

Authors	Country	Period	Methodology	Conclusion
Adabor, O. (2023)	Ghana	2011Q-2020Q	ARDL	GRR-FD
Li, Y., et al. (2022).	E15	2000-2020	FMOLS, DOLS	FD-HC
Huang, S. Z., et al. (2021).	USA	1995-2015	QARDL	NRR, FD, URB-CO2
Abbasi, M. A., et al. (2020).	8 AC	1982-2017	Panel co-integration and Granger causality techniques	FD-GDP-CO, URB-EC-CO
Sekali, J., & Bouzahzah, M. (2019).	Morocco	1980-2015	ARDL	FD-CO
Zaidi, S. A. H., et al. (2019).	OECD Countries	1990 to 2016	Cup-FM ordinary least squares	GI, NR, HC-FD, NR-FD
Dogan, E., & Turkekul, B. (2016).	USA	1960 to 2010	ARDL	CO,GDP-EC, UR-FD,
Shahbaz, M., et al. (2013).	Malaysia	1971-2011	Aggregate growth model under equilibrium framework	CO2-FD-EC-GDP
Shahbaz, M., et al. (2013).	Indonesia	1975Q1-201Q4	ARDL	GDP-CO2, FD-CO2
Ilhan Ozturk & Ali Acaravci	Turkey	1960-2007	ARDL	GDP,-CO2, FD Has no effect on co2
Sadorsky, P. (2010).	22 Developing countries	1990-2006	GMM	FD-EC

3. DATA AND METHODOLOGY

3.1. Model Construction

As we mentioned in the general introduction and literature interview, the main purpose of this study is to test the long run and causal relationship between CO_2 emissions, natural resource rents, natural gas rents, financial development and urbanization. Annual data 1990 to 2021 on Türkiye and South Africa are taken from World Bank Data indicator. For this reason, the authors will perfrom different analysis, descriptive statistics, unit root test to find if the variables are stationary or non-stationary at level. First, we employ the ARDL (Autoregressive Distributed Lag Model) model to measure the model's criteria and assess its dependability and stability. Information will be estimated before the ARDL, descriptive and normality analyses will be examined. The relationship between the dependent and independent variables, which is the driving force behind this study, is presented below:

$$\mathrm{CO2} = \mathrm{f}\ (\mathrm{NGR}, \mathrm{TNRR}, \mathrm{FD}, \mathrm{URB}) \tag{1}$$

Model Specification:

The mathematical formulation of the model is presented as follows:

$$CO_{2t} = \breve{\alpha}_1 + \beta_1 NGR_t + \beta_2 TNRR_t + \beta_3 FD_t \ + + \beta_4 URB_t + \epsilon_t \tag{2}$$

$\breve{\alpha}_1$: Constant term

- $\beta_1\ \beta_2$, $\beta_3\ \beta_4$,: Coefficients of the explanatory variables;

ϵ_t: Model Error Correction Term

3.2. Descriptive Statistics

The descriptive statistics in table 2 shows that the mean of CO_2 is 12.76 its maximum and minimum values are 13.01 and 12.38 respectively, the standard deviation values of all variables compared to the average values are low showing relatively lower volatility. From the descriptive statistics table below all the variables carbon dioxide emissions, financial development and urbanization are skewed negatively, other variables natural gas resource and total natural resource rents are positively skewed. The probability values of Jarque-Bera test reveal that all the variables normally distributed except the financial development.

Table 2. Descriptive Statistics

Variables	CO2	NGR	TNRR	FD	URBAN
Mean	12.76	-3.66	1.53	4.73	4.08
Median	12.84	-3.69	1.53	4.77	4.08
Maximum	13.01	-2.84	2.48	4.95	4.20
Minimum	12.38	-4.36	0.91	4.27	3.95
Std. Dev.	0.218	0.35	0.32	0.14	0.07
Skewness	-0.447	0.32	0.64	-1.19	-0.07
Kurtosis	1.621	3.42	4.15	4.89	1.80
Jarque-Bera	3.26	0.70	3.64	11.24	1.74
Probability	0.195	0.70	0.16	0.00	0.41
Sum	370.1	-106.2	44.41	137.3	118.4
Sum Sq. Dev.	1.333	3.51	2.93	0.56	0.15
Observations	29	29	29	29	29

3.3. Correlation Analysis

The correlation analysis in Table 3 shows that the correlation coefficients show low or moderate relation.

Table 3. Correlation Coefficient

Variables		CO_2	NGR	TNRR	FD	Urban
Pearson Correlation	CO_2	1				
	NGR	0.03	1			
	TNRR	0.235	0.718	1		
	FD	0.442	0.647	0.745	1	
	Urban	0.435	-0.658	-0.628	-0.557	1

3.4. Collinearity Statistics

The collinearity result demonstrates that there are no issues with multicollinearity with the variables. The absence of multicollinearity was confirmed using the variance inflation factor (VIF) study. The VIF analysis stipulates that the variables must have a VIF value below 10 and a tolerance value greater than 0.10 in order to be free from multicollinearity issues.

Table 4. Collinearity Statistics

	Collinearity Statistics	
Variables	Tolerance	VIF
NGR	.399	2.509
TNRR	.334	2.995
FD	.416	2.405
Urban	.513	1.947

a. Dependent Variable: CO_2

Unit root test

In advance of analyzing empirical research, it is necessary to look at the variable's unit root test. The majority of macroeconomic time series exhibit non-stationarity at some level, which can cause issues for analysts who are not given the right tools. The findings of the Augmented Dickey-Fuller (ADF)-Dickey (1979) based unit root test are shown in Table 5.

Table 5. Results of Unit Root Test

Variables		ADF Test	t-static	Prob-Values	Decision rules
CO_2	1%	-3.68***	-6.03****		I(1)
	5%	2.97****		0	
NGR	1%	-3.66****			I(0)
	5%	-2.96****	3.16****	0.0318	
TNRR	1%	-3.66****	-3.39****		I(0)
	5%	-2.96****		0.0187	
FD	1%	-3.68****	-4.12****		I(1)
	5%	-2.97****		0	
URBAN	1%	4.97****	-4.35****	0	I(0)
	5%	-3.57****			

Both level I(0) and first difference I(1) are subjected to the unit root test, as shown in Table above. For the ADF test for carbon dioxide emissions and financial development become stationary at first level while natural gas rents, total natural resource rents and urbanization become stationary at level.

3.5. Lag Length Criteria

The lag length requirements based on AIC are shown in Table 5. The ideal lag is determined by the four information criteria (LR, FPE, SC, and HQ), and the ideal lag is determined by the AIC. The AIC criterion effectively estimate p. p = 2 will be kept because this series length.

Table 6. Lag Length Criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-422.0865	NA	1.27e+08	32.85281	33.09475	32.92248
1	-223.2448	305.9102	207.1230	19.48037	20.93202	19.89840
2	-179.4990	50.47603*	62.33761*	18.03838*	20.69974*	18.80476*

4. EMPIRICAL RESULTS AND DISCUSSION

4.1. ARDL F-Bounds Testing Approach to Cointegration

For this study, we chose a different method that of the automatic distributed lag (ARDL) test approach for cointegration, introduced by Pesaran and Shin (1999) and developed by Pesaran et al. (2001). This justification has several reasons. First, this test can be applied to non-stationary time series without constraints of the same order of integration, unlike other tests. In addition, homogeneity is not an issue with this method (Harris and Sollis, 2003).

$$\Delta LCO_{2t} = \beta_0 + \sum_{i-1}^{p} \delta_1 \, \Delta LCO_{2t-1} + \sum_{i-1}^{p} \alpha_1 \, \Delta LNGR_{t-1} + \sum_{i-1}^{p} \gamma_1 \, \Delta LTNRR_{t-1} + \sum_{i-1}^{p} \omega_1 \, LFD_{t-1} + \sum_{i-1}^{p} \omega_1 \, LURB_t + A_1 LCO_{2t-1} + A_2 LNGR_{t-1} + A_3 LNGR_{t-1} + A_4 LTNRR_{t-1} + A_5 LFD_{t-1} + A_6 LURB_t + \cup_t \quad (3)$$

Where β_0 is the drift component, and $\cup_t$ a white noice. The terms with summation signs represent the error correction model, while those with co-efficient p_t represents the long term relationship. The verification of the co integration relations is implemented with bounds test. The latter consists of conducting an F test on the hypothesis $p_1 = p_2 = p_3 = p_4 = p_5 = 0$ against the alternative hypothesis $p_1 \neq p_2 \neq p_3 \neq p_4 \neq p_5 \neq 0$ the statistics of F, thus calculated, two critical thresholds are compared: a low-range LB and a higher-range SB range, established by Pesaran et al. (2001). If the F-statistic is below the lower range, the null hypothesis of non-cointegration will not be rejected, whereas if the F-statistic is above the upper range, the null hypothesis will be rejected, which indicates a cointegration relationship between the variables. On the other hand, if the F statistic lies between the two extremes, the "bounds test" is said to be inconclusive.In order to select the optimal delay for each variable, the ARDL $(\rho + 1)^k$ method estimates regression, where: is the maximum number of delays and k is the number of variables in the equation. The model can be selected based on the Akaike Information Criterion (AIC). AIC allows you to specify the maximum number of delays. After the selection of the ARDL model by the AIC, the long-term relationships can be estimated. Once this is established, the error correction model can be estimated:

$$\Delta LCO_{2t} = \beta_0 + \sum_{i-1}^{p} \delta_1 \, \Delta LCO_{2t-1} + \sum_{i-1}^{p} \alpha_1 \, \Delta LNGR_{t-1} + \sum_{i-1}^{p} \gamma_1 \, \Delta LTNRR_{t-1} + \sum_{i-1}^{p} \omega_1 \, LFD_{t-1} + \sum_{i-1}^{p} \omega_1 \, LURB_t + \mu ECM_{t-1} \quad (4)$$

4.2. Cointegration Test

4.2.1. F-Bounds Test for Cointegration

The F-bounds test was used in order to determine the short and long-term relationship between carbon dioxide emissions and its variables. The test shown in Table 6 below, there is a long run relationship between the variables since the F-Statistic value is (10.74) and greater than the critical bound value (4.35) this shows us the long run relationship between the variables.

Table 7. F-Bounds Test

Test Statistic	Value	Signif.	I(0)	I(1)
F-statistic	10.74	10%	2.45	3.52
K	4	5%	2.86	4.01

4.3. Long run ARDL Model

The long run estimates are presented in Table 7: the result of R^2 value reveals that about 88% variation in CO_2 is explained by the independent factor of this article. The F-Statistic and its probability value shows the that model is statistically significant. The Durbin Watson statistics is 2.25 which is close to the benchmark 2.0 in the model. It recommends that there is no serial or auto correlational in the model specification.

Table 8. ARDL Error Correction Regression

Dependent Variable: DLOG(CO2)				
Method: ARDL				
Selected Model: ARDL (1, 2, 3, 1,0)				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	1.38	0.3	4.63	0
LOG(CO2(-1))*	-0.61	0.13	-4.66	0
LOG(NGR(-1))	0.09	0.02	4.15	0
LOG(TNRR(-1))	0.04	0.02	1.79	0.09
LOG(FD(-1))	0.09	0.09	1	0.33
LOG(URBAN)**	1.53	0.34	4.56	0
DLOG(NGR)	-0.03	0.02	-1.62	0.13
DLOG(NGR(-1))	-0.06	0.02	-3.15	0.01
DLOG(TNRR)	0.1	0.02	5.34	0
DLOG(TNRR(-1))	0.04	0.02	1.91	0.08
DLOG(TNRR(-2))	0.04	0.02	2.38	0.03
DLOG(FD)	0.22	0.08	2.8	0.01
CointEq(-1)*	-0.61	0.09	-6.9	0

R-squared	0.85
Adjusted R-squared	0.8
S.E. of regression	0.02
Sum squared resid	0.01
Log likelihood	74.08
F-statistic	15.77
Durbin-Watson stat	2.22
Prob(F-statistic)	0

The results of the long-term relationship indicate the signs of coefficient follow the theoretical expectation, according to the findings the natural gas rents, total natural resource rents, financial development and urbanization have a positive effect on co2 and statistically significant. The results suggest that an increase in natural gas rents, total natural resource rents, financial development and urbanization increases in co2. The unit increase of the total natural resource rents will also increase carbon dioxide emissions by 0.10 in Türkiye and South Africa.

4.4. Diagnostic Test Results

From the diagnostic test results in table 8, it can be detected that at 5% significance level, there is no serial correlation and heteroscedasticity problem in this study. The model is also well specified as exposed by the Ramsey RESET.

Table 9. Diagnostic test results

Specification	F-statistics	Prob. Value
Breusch–Godfrey (Serial Correlation LM test)	0.59	0.46
Breusch-Pagan (Heteroscedasticity)	0.76	0.69
Ramsey RESET	1.37	0.27

4.5. Cusum Tests

The evaluation of model stability is performed using the CUSUM test, and Ploberger and Kramer (1990) demonstrate the local strength of the CUSUM and CUSUM of squares tests. The CUSUM test looks at the stability of data to see if the model can be used to policy-related problems. Therefore, if a model passes the stability tests for the residuals and squares, it is said to be stable. The following graphs show how stable the model is according to the CUSUM test results.

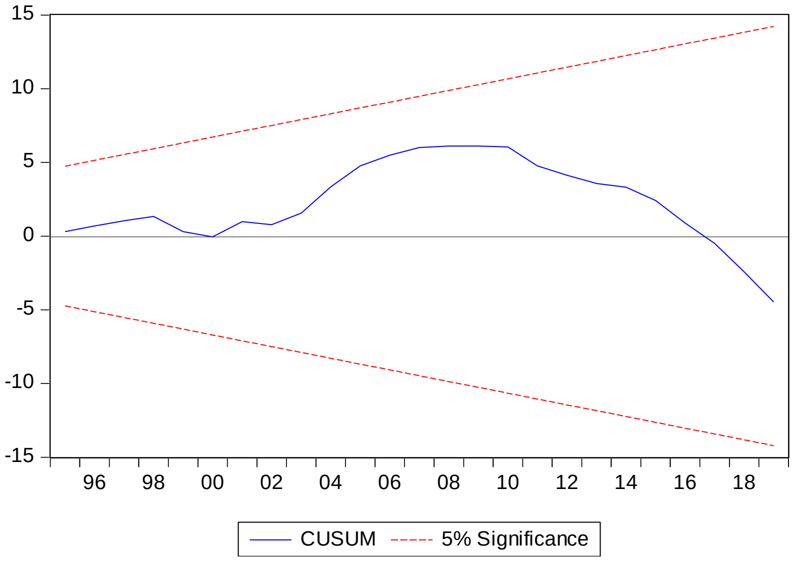

Figure 1. CUSUM plots

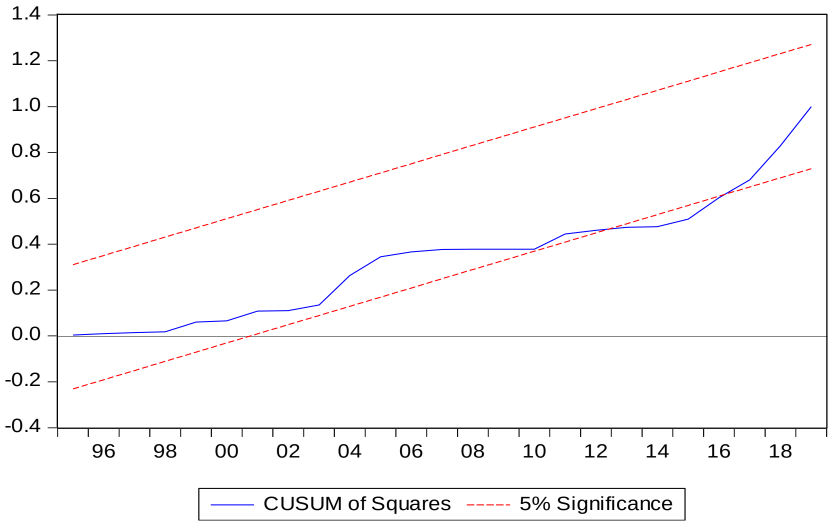

Figure 2. CUSUM of Squares

4.6. Granger Causality Test

According to the granger causality analysis we will be able to detect statistically significant relationships between the five model variables. This causality must be examined before examining the dynamics of the model. Let us not forget that, according to Granger, a variable X is said to be the cause of a variable Y if examining the latter increases the predictability of the former. The following results are obtained:

Table 10. Granger Causality

Null Hypothesis:	Obs	F-Statistic	Prob.
D(NGR) does not Granger Cause D(CO2)	27	3.70950	0.0409
D(CO2) does not Granger Cause D(NGR)		3.96400	0.0339
D(TNRR) does not Granger Cause D(CO2)	27	2.39799	0.1143
D(CO2) does not Granger Cause D(TNRR)		1.32555	0.2861
D(FD) does not Granger Cause D(CO2)	25	0.08137	0.9222
D(CO2) does not Granger Cause D(FD)		2.00543	0.1608
D(URBAN) does not Granger Cause D(CO2)	27	1.34675	0.2807
D(CO2) does not Granger Cause D(URBAN)		2.49847	0.1052
D(TNRR) does not Granger Cause D(NGR)	29	0.15173	0.8600
D(NGR) does not Granger Cause D(TNRR)		0.85120	0.4394
D(FD) does not Granger Cause D(NGR)	27	4.68339	0.0202
D(NGR) does not Granger Cause D(FD)		4.31995	0.0262
D(URBAN) does not Granger Cause D(NGR)	29	6.74744	0.0047
D(NGR) does not Granger Cause D(URBAN)		3.95324	0.0328
D(FD) does not Granger Cause D(TNRR)	27	2.17693	0.1372
D(TNRR) does not Granger Cause D(FD)		0.50216	0.6120
D(URBAN) does not Granger Cause D(TNRR)	29	0.16090	0.8523
D(TNRR) does not Granger Cause D(URBAN)		0.83747	0.4451
D(URBAN) does not Granger Cause D(FD)	27	1.79162	0.1902
D(FD) does not Granger Cause D(URBAN)		0.10596	0.8999

Y does not cause X, if H0 is accepted, at the threshold $\alpha = 5\%$. The H0 hypothesis is accepted if the p-value > 5%.

Causality test between NGR and CO2: The null hypothesis that the **NGR** does not Granger Cause **CO_2** is rejected. At Granger's sense (differentiated series), Carbon Dioxide Emissions influence the Natural Gas Resources at the 5% threshold over the period studied. However, it should be noted that reverse causality is statistically rejected.

Causality test between TNRR and CO_2: The two null hypotheses are accepted. There is no causality between **TNRR and CO_2** at Granger's sense.

Causality test between FD and CO_2: The two null hypotheses are accepted. There is no causality between **FD and CO_2** at Granger's sense.

Causality test between URBAN and CO_2: The two null hypotheses are accepted. There is no causality between **URBAN and CO_2** at Granger's sense.

Causality test between TNRR and NGR: The two null hypotheses are accepted. There is no causality between TNRR and NGR at Granger's sense.

Causality test between FD and NGR: The null hypothesis that the **FD** does not Granger Cause **NGR** is rejected. At Granger's sense (differentiated series), Financial Developments influence the Natural Gas Resources at the 5% threshold over the period studied. However, it should be noted that reverse causality is statistically rejected.

Causality test between URBAN and NGR: The null hypothesis that the **URBAN** does not Granger Cause **NGR** is rejected. At Granger's sense (differentiated series), Urbanization influences the Natural Gas Resources at the 5% threshold over the period studied. However, it should be noted that reverse causality is statistically rejected.

Causality test between FD and TNRR: The two null hypotheses are accepted. There is no causality between **FD and TNRR** at Granger's sense.

Causality test between URBAN and TNRR: The two null hypotheses are accepted. There is no causality between **URBAN and TNRR** at Granger's sense.

Causality test between URBAN and FD: The two null hypotheses are accepted. There is no causality between **URBAN and FD** at Granger's sense.

Table 11: VAR Granger Causality/Block Exogeneity Wald Tests

Dependent variable: LOG(CO_2)

Excluded	Chi-sq	df	Prob.
LOG(NGR)	5.450047	2	0.0655
LOG(TNRR)	0.588196	2	0.7452
LOG(FD)	6.507483	2	0.0386
LOG(URBAN)	16.05292	2	0.0003
All	31.44163	8	0.0001

Dependent variable: LOG(NGR)

Excluded	Chi-sq	df	Prob.
LOG(CO_2)	1.279870	2	0.5273
LOG(TNRR)	0.384824	2	0.8250
LOG(FD)	6.515746	2	0.0385
LOG(URBAN)	0.806585	2	0.6681
All	7.051532	8	0.5311

Dependent variable: LOG(TNRR)

Excluded	Chi-sq	df	Prob.
LOG(CO_2)	5.684841	2	0.0583
LOG(NGR)	0.148108	2	0.9286
LOG(FD)	13.23119	2	0.0013
LOG(URBAN)	6.271822	2	0.0435
All	18.92831	8	0.0152

Dependent variable: LOG(FD)

Excluded	Chi-sq	df	Prob.
LOG(CO_2)	4.851595	2	0.0884
LOG(NGR)	1.328447	2	0.5147
LOG(TNRR)	1.094258	2	0.5786
LOG(URBAN)	5.261144	2	0.0720
All	26.87913	8	0.0007

Dependent variable: LOG(URBAN)

Excluded	Chi-sq	df	Prob.
LOG(CO_2)	1.495424	2	0.4734
LOG(NGR)	10.58110	2	0.0050
LOG(TNRR)	1.561081	2	0.4582
LOG(FD)	0.338412	2	0.8443
All	21.97051	8	0.0050

Block Exogeneity Wald Tests is another technique or a robust measure to identify whether the variables granger cause each other or not. The independent variable does not granger causes the dependent variable, The lag values of dependent variables CO2 show granger cause the independent variables financial development and urban. The lag values of NGR shows granger causes the financial development. The lag value of TNRR show granger cause the financial development and urban. The lag value of Urban show granger causes the natural gas resources.

5. CONCLUSION AND DISCUSSION

This study examines an assessment of the impact of natural resource rent, financial development, and urbanization on carbon dioxide emissions in South Africa and Türkiye. For the period 1990-2021. In order to determine the impact of financial development to environment we applied ARDL (Autoregressive Distributed Lag Model).

We employed this article the unit root test, co integration test and ARDL. The co integration test appears the long run relationship between carbon dioxide emissions, financial development, natural gas resources, urban and natural resource rents.

The results of the ARDL cointegration test demonstrate that the variables have a long-term link between the variables. According to the Granger causality test, there is a two-way relationship between urbanization, financial development, and natural gas rentals as well as carbon dioxide emissions and rents for natural gas. Granger Causality/Block Exogeneity Wald Tests shows that there is a link between carbon dioxide emissions and financial development.

According to this study, Türkiye and South Africa in order to achieve their financial development and CO_2 and to increase their investment in energy projects in order to realize their full energy potential, these countries should increase their energy productivity by increasing energy efficiency, GHG, implementing energy savings projects, conserving energy, and outsourcing their energy infrastructure.

REFERENCES

1. Abbasi, M. A., Parveen, S., Khan, S., & Kamal, M. A. (2020). Urbanization and energy consumption effects on carbon dioxide emissions: evidence from Asian-8 countries using panel data analysis. *Environmental Science and Pollution Research*, *27*(15), 18029-18043.
2. Adabor, O. (2023). The effect of financial development on natural gas resource rent in Ghana. *Resources Policy*, *83*, 103620.
3. Ali, H. S., Law, S. H., Lin, W. L., Yusop, Z., Chin, L., & Bare, U. A. A. (2019). Financial development and carbon dioxide emissions in Nigeria: evidence from the ARDL bounds approach. *GeoJournal*, *84*, 641-655.
4. Bekun, F. V., Alola, A. A., & Sarkodie, S. A. (2019). Toward a sustainable environment: Nexus between CO2 emissions, resource rent, renewable and nonrenewable energy in 16-EU countries. *Science of the total Environment*, *657*, 1023-1029.
5. Dogan, E., & Turkekul, B. (2016). CO_2 emissions, real output, energy consumption, trade, urbanization and financial development: testing the EKC hypothesis for the USA. *Environmental Science and Pollution Research*, *23*, 1203-1213.
6. Huang, S. Z., Sadiq, M., & Chien, F. (2021). The impact of natural resource rent, financial development, and urbanization on carbon emission. *Environmental Science and Pollution Research*, 1-13.
7. Li, Y., Mehmood, N., & Iqbal, N. (2022). Natural resource abundance and financial development: A case study of emerging (E− 15) economies. *Resources Policy*, *79*, 103018.
8. Ozturk, I., & Acaravci, A. (2013). The long-run and causal analysis of energy, growth, openness and financial development on carbon emissions in Turkey. *Energy economics*, *36*, 262-267.
9. Sadorsky, P. (2010). The impact of financial development on energy consumption in emerging economies. *Energy policy*, *38*(5), 2528-2535

10. Sekali, J., & Bouzahzah, M. (2019). Financial development and environmental quality: empirical evidence for Morocco. *International Journal of Energy Economics and Policy*, *9*(2), 67.
11. Shahbaz, M., Solarin, S. A., Mahmood, H., & Arouri, M. (2013). Does financial development reduce CO_2 emissions in Malaysian economy? A time series analysis. *Economic Modelling*, *35*, 145-152.
12. Shahbaz, M., Tiwari, A. K., & Nasir, M. (2013). The effects of financial development, economic growth, coal consumption and trade openness on CO_2 emissions in South Africa. *Energy policy*, *61*, 1452-1459.
13. Shahbaz, M., Tiwari, A. K., & Nasir, M. (2013). The effects of financial development, economic growth, coal consumption and trade openness on CO2 emissions in South Africa. *Energy policy*, *61*, 1452-1459.
14. Sun, H., Samuel, C. A., Amissah, J. C. K., Taghizadeh-Hesary, F., & Mensah, I. A. (2020). Non-linear nexus between CO_2 emissions and economic growth: a comparison of OECD and B&R countries. Energy, 212, 118637.
15. Zaidi, S. A. H., Wei, Z., Gedikli, A., Zafar, M. W., Hou, F., & Iftikhar, Y. (2019). The impact of globalization, natural resources abundance, and human capital on financial development: Evidence from thirty-one OECD countries. *Resources policy*, *64*, 101476.