A G D I Working Paper

WP/20/011

New Insight into the Causal Linkage between Economic Expansion, FDI, Coal consumption, Pollutant emissions and Urbanization in South Africa [1]

Forthcoming: Environmental Science and Pollution Research

Udi Joshua
Department of Economic,Federal University Lokoja,
P.M.B 1154 Lokoja, Kogi state, Nigeria
Email: udijoshua@yahoo.com

Festus V. Bekun[2]
Faculty of Economics Administrative and Social sciences,
Istanbul Gelisim University, Istanbul, Turkey
&
Department of Accounting, Analysis and Audit
School of Economics and Management
South Ural State University, 76, Lenin Aven.,
Chelyabinsk, Russia 454080.

African Governance and Development Institute,
P.O. Box 8413, Yaoundé, Cameroon.
&
Research Fellow European Xtramile Centre of African Studies, Liège, Belgium
E-mail: fbekun@gelisim.edu.tr

Samuel A. Sarkodie
Nord University Business School (HHN)
Post Box 1490, 8049 Bodø, Norway
Email: asumadusarkodiesamuel@yahoo.com

[1] This working paper also appears in the Development Bank of Nigeria Working Paper Series.
[2]Corresponding author: festus victor Bekun; Email:fbekun@gelisim.edu.tr

2020 African Governance and Development Institute WP/20/011

Research Department

New Insight into the Causal Linkage between Economic Expansion, FDI, Coal consumption, Pollutant emissions and Urbanization in South Africa

Udi Joshua, Festus V. Bekun & Samuel A. Sarkodie

January 2020

Abstract

This study examines the relationship between foreign direct investment inflows and economic growth by incorporating the role of urbanization, coal consumption and CO_2 emissions as additional variables to avoid omitted variable bias. The different order of integration from the unit root test suggested the adoption of a dynamic autoregressive distributed lag bounds testing procedure. The results confirmed the existence of a long-run equilibrium relationship between the outlined series within the period under investigation with a high speed of convergence. The ARDL equilibrium relationship shows that coal consumption is the largest emitter of carbon dioxide emissions in both short- (0.77%) and long- (0.86%) run. Economic growth was found to escalate CO_2 emission by approximately 0.27% (in the short-run) and 0.19% (in the long-run). The Granger causality test indicates a non-causal effect between FDI inflow and economic expansion in South Africa, which implies that FDI is not a driver of economic advancement. The empirical study shows a bidirectional causal effect between urbanization and foreign direct investment. This suggests that urban development stimulates foreign direct investment in South Africa. The findings reveal a one-way link from GDP to coal consumption, suggesting economic prosperity promotes coal consumption. The study underscores that economic development and the attraction of more economic investments is in part, dependent on the conservative policy, development of urban centres through infrastructural improvement, and establishing industrial zones.

Keywords: South Africa; coal consumption; CO_2 emissions; climate change; urbanization

1. Introduction

Foreign direct investment (FDI hereafter) is seen by some scholars as a panacea for economic growth through its spillover effect especially to the developing economies. However, a consensus is yet to be established as to whether the impact of FDI inflow is gainful to the economic progress of the host countries. Some studies (Flora & Agrawal 2014; Mehic *et al.* 2017 Kalai & Zghidi, 2019; Pradhan *et al.* 2019) identify FDI inflow as a driving force for economic advancement. These studies label FDI inflow as a promoter of productivity, research and development, civilization, and improvement of skill and technical know how.

In contrast, some studies believe that FDI inflow is anti-economic progress, these include Joshua (2019). The study found a none-causal effect between economic expansion and FDI inflow in Nigeria. Similar to Bezuidenhou (2009) who reveals FDI as rather harmful to the economic progress of the host country, thus, FDI inflow is an engine of retardation to the host economy.

The linkage between coal consumption and economic expansion remains inconclusive. Some empirical findings from previous studies such as Joshua and Bekun (2020) adopted the dynamic ARDL approach and found that consumption promotes economic expansion both in the short- and long- run in South Africa is consistent with the work of Joshua et al., (2020). Other related studies supporting this claim include Bekun *et al.* 2018; Bekun*et al.* 2019; Apergis and Payne 2010. Other scholars believe the nexus works the opposite way (see: Govindaraju and Tang 2013; Zhang and Xu 2012; Jinke*et al.* 2008). These studies submit that coal consumption exhibits negative impact on economic expansion, thus, coal usage is an anti-growth agent. Other studies reveal that coal consumptionand economic advancement exhibit a mutual benefit (see: Belke*et al.* 2011; Fuinhas and Marques 2011; World-Rufael 2010; Paul and Bhattacharya 2004). A study particularly found a mutual interaction between the variables of interest (Paul and Bhattacharya 2004). On a related note, the outcome of other studies remains neutral regarding the impact of coal consumption on economic advancement (Ziramba 2009; Jinke*et al.* 2008; Lee and Chang 2005; Sari and Soytas 2004; Yang 2000). These studies maintain that the positive impact of FDI inflow on economic advancement as posited by some quotas is a mere presumption and not a reality.

South African is one of the very few largest and fastest emerging economies in Africa and globally. Its economy demonstrates peculiar characteristicsdifferent from other emerging

economies in Africa. These distinctive features includean economy that is the largest emitter of CO_2 emissions in Africa (~45% of the continental total) and 7th in the world (WEC 2016). In addition, the share of energy generated from coal is about 77% of the total energy generation capacity and remains the largest consumer of the coal in Africa (EIA, 2010; Nasr *et al.* 2015; WEC 2016). South Africa is the largest producer of natural resources such as gold, iron ore, and platinum (World Bank economic indicators, 2018). However, the country has witnessed turbulent in its quest to achieve both economic growth and FDI inflow. Despite this instability, the economy remains one of the leading economies in Africa especially after the takeoff of democracy in the country in 1994. For instance, in 2001 and 2002,the South African domestic currency weakened against the US dollar by 37%. This resulted in capital flight as investors discontinued their investment for fear of losing capital. Consequently, the rate of growth of GDP dropped significantly in the preceding year from 3% to 1.9% between 2002 and 2003. In 2005, GDP stood at $6729.827 billion in absolute values. This rose to $7432.117 billion in 2008 with a further increase in 2013 to 7563.993. In 2017, the GDP growth rate was estimated to be 0.7%, while unemployment accounted for 27% of the workforce. On the other hand, South Africa stands as a leader of FDI inflows to the Southern region and second-largest in Africa after Nigeria(UNCTAD 2012 $ 2018). The report further indicates that South African received the second largest proportion of the FDI inflows to the continent in 2011, accounting for about 13.6% share of the total. In 2013, South Africa received FDI inflows of about $8300.1 million, followed by Mozambique which received $6175.1 million. In 2017, the FDI inflows to South Africa stood at $2.0 billion (UNCTAD, 2018). In 2018, the FDI inflows to the southern region experienced an increase by 13% to $32 billion out of which South Africa received the largest share of about $5.3 billion, a sharp increase compared to 2017. It is estimated that about 87% of the total FDI inflows to South Africa come from the UK, whereas the rest of the world account for the remaining percentage (UNCTAD, 2013).

These distinctive characteristics informed this study with the intention of adopting the TY Granger causality test using one functional model to achieve the following objectives: first, carry out a country-specificstudy on the FDI-led growth hypothesis because ofno consensus in the empirical literature (Guimaraes *et al.* 2000; Fedderke & Romm 2006; Shahbaz et al., 2013; Sunde 2017; Khobai *et al.* 2017), especially for South Africa. Second, Nielsen *et al.* (2017) argued that industrialization, infrastructure improvement and the seat of power (government) that

characterizes the urban centre could serve as a catalyst for attracting FDI inflows.The study opines that urban conglomeration with improved infrastructures is an agent for attracting FDI inflow into the host country, that is, urban centres are attractive sights for the inflow of new investors into the host country. This study seeks to investigate this claim by incorporating urbanization, coal usage,and CO_2 emissions in the FDI-growth hypothesisas control variables. Finally, this study examines the growth hypothesis which posits that coal consumption is a key driver of economic expansion. Thus, this study is well articulated and will serve as a pioneer work in future research, especially in the case of South Africa.

2. Literature Review

The contention of the dynamic of FDI and its impact on economic expansion is yet to receive an empirical conclusion. While some quotas lend their support to the alleged positive impact of FDI inflow on economic progress, others reject it in totality. Joshua et al., (2020) examined the interaction between FDI inflows and economic expansion in South Africa using the dynamic ARDL approach. The findings revealed that FDI inflow exerts a positive impact on economic expansion both in the short- and long- run, which is not different from Shahbaz et al., (2019). The study revealed that FDI promotes economic growth through its positive spillover effect on the quality of the environment consistent with the work of Balcilar et al., (2019). Shahbaz et al., (2019) carried out similar work on the relationship between FDI inflows, education and transportation infrastructure in the French economy using ARDL approach. The result revealed that cointegration between the series of interest. Further revelation showed that the relationship between FDI inflows and economic expansion is bidirectional. Shahbaz and Rahman (2012) examined the relationship between financial developments, import and FDI inflows in Pakistan by adopting an ARDL bounds approach. The findings confirmed cointegration between the series and that FDI exerts a positive and significant impact on economic expansion. In addition, a bidirectional relationship between FDI inflows and economic expansion was confirmed. According to Gungor and Katircioglu (2010), FDI drives economic growth positively in the case of Turkey. This is similar to the work of Gungor and Rigim (2017) for the case of Nigeria. Other extant literature (Sunde, 2017, Tshepo, 2014, Abbes *et al.* 2015, Nistor 2014, Almfraji and Almsafir, 2014, Omr and Kahoulib, 2013, Shahbaz and Rahman, 2013) subscribe to the FDI-economic growth nexus. The spillover effect of FDI inflow is argued to drive economic progress

faster than domestic investment (Borensztein *et al.* 1998), whereas others (Nair-Reichert and Weinhold 2001) argue that FDI could influence future growth in an open economy more than a closed economy. The impact of FDI inflows on economic progress though positive but was insignificant in the case of Nigeria (Ayanwale, 2007), however, FDI inflows to India exerts a transitory effect on the service sector output (Chakraborty and Nunnenkamp, 2008). Azman-Saini *et al.* (2010) submit that the impact of FDI inflow on economic advancement is not in view without attaining the minimum financial market development. Wang (2009) reveals that FDI inflow in the manufacturing industry promotes economic growth positive in a significant way for 12 Asian economies understudied, confirming the work of Yao (2006) in the case of China. Omri*et al.* (2014) find a two-way interaction between FDI inflow and economic growth for three regions studied, but, the impact of FDI inflow could only be triggered by a strong financial improvement of the host country (Hermes and Lensink, 2003). Fedderke and Romm (2006) confirm the complementary role of FDI inflow in the long-run in South Africa. On the contrary, other studies argued that FDI influences economic expansion negatively. Other studies with opposing view include Abdouli and Hammami 2017. The study examined the relationship between FDI inflows and economic expansion in the MENA countries and found a negative impact of FDI on economic progress in Egypt and Lebanon. The study of Adams (2009) revealed only a short-run negative effect of FDI on domestic investment which by implication hampers economic growth. Other studies remain neutral as to whether or not FDI inflow drives economic growth. Fedderke and Romm (2006) asserted that FDI causes capital flight in the short-run.Belloumi (2003) showed that FDI inflows do not significantly influence economic progress in Tunisia. Alfaro *et al.* (2004) asserted that the influence of FDI inflow on economic expansion without complementary role from other factors like the improved financial market is uncertain. Joshua (2019) examined the relationship between FDI inflows, government expenditure and economic expansion in Nigeria using the dynamic ARDL. The result revealed that FDI inflows do not drive economic prosperity. Similarly, (Flora and Agrawa 2014; Pandya and Sisombat 2017; Mehic et al. 2013). Goh et al. (2017) submitted that on the overall, there is no evidence of the positive impact of FDI in the long-run for the Asian economies, confirming the work of Mah (2010) and Khobai et al. (2017). Bezuidenhout (2009) proved that the perceived impact of FDI on economic growth is a fallacy for the southern Africa region.

The linkage between coal consumption and economic expansion remains inconclusive. Some empirical findings from previous studies such as Joshua and Bekun (2020) examined the relationship between coal consumption and economic expansion in South Africa using the dynamic ARDL. The findings revealed that coal consumption is a promoter of economic progress both in the short- and long- run, as well as, an emitter of carbon emissions. This is similar to the work of Joshua et al., (2020) which examined the relationship between coal consumption, FDI inflows, economic expansion and industrialization in South Africa. The findings showed a co-movement between the series in the long term and that coal consumption is a key factor in promoting economic growth in both terms and that the variables co-move in the distance time. Bekun*et al.* 2018 and Bekun*et al.* 2019 in separate studies found that coal consumption exerts a positive and significant impact on economic acceleration in South Africa both in the short- and long- run. The study further revealed a cointegration between the series within the period under review. This is similar to Balsalobre-Lorente et al., (2018), who examined the relationship between carbon emission and economic expansion renewable electricity and natural resources in five EU countries. The findings revealed that renewable electricity, natural resources and energy innovation promotes the quality of the eco-system. Alvarez-Herranz et al., (2017) examined the relationship between energy innovation, renewable energy and carbon emission in 17 OECD economies. The findings revealed that energy innovation and renewable energy demonstrates a positive impact on economic expansion. Further revelation showed that energy innovation and renewable energy mitigate carbon emission. The study of Alola and Alola (2019) found a cointegration between the series in South Africa. Shahbaz et al., (2019) examined a similar relationship in the MENA economy and found an inverted shape link between economic expansion and carbon emission. Saidi et al., (2019) examined the empirical link between transport energy consumption transport infrastructure and economic advancement in the MENA economies. The study found that transport energy usage exerts a positive impact on the economic growth of N-GCC and MATE part of the MENA, while transport infrastructure influences economic advancement of the MENA region. Adedoyin et al., (2019) found a negative impact of coal rent on carbon emission in the BRICS economies. Others related studies (Apergis and Payne 2010; Ziramba 2009; World-Rufael 2010, 2009, 2007, 2004; Yuan *et al.* 2007; Shui and Lam 2004) validated the coal consumption-led economic expansion nexus, whereas others believe the nexus works the opposite way (Govindaraju and Tang 2013;

Zhang and Xu 2012; Jinke*et al.* 2008; Reynolds and Kolodziej 2008; Soytas and Sari, 2003). Other studies revealed that coal consumptionand economic advancement exhibit a mutual benefit (Belke*et al.* 2011; Fuinhas and Marques 2011; World-Rufael 2010; Paul and Bhattacharya 2004; Yuan *et al.* 2008). On the concluding note, the outcome of several studies remains neutral regarding the impact of coal consumption on economic advancement (Ziramba 2009; Jinke*et al.* 2008; Lee and Chang 2005; Sari and Soytas 2004; Yang 2000). These studies submit that the impact of coal consumption on economic expansion is a mere presumption which is far from reality.

2.1 Theoretical framework

This study is developed based on modernization and dependency theories. The modernization theory argues that FDI is an advantage to the host country especially the emerging economies because of its spillover effect in the form of, *inter alia*, technological advancement, and human capital development (Li &Liu2005; Pradhan & Kumar 2002 and Borenszte*in et al.* 1998). The school of thought believes in economic openness which facilitates the inflows of FDI,hence, FDI is a key player in the economic expansion of the host country, especially developing economies. They conclude that though FDI inflows may not be totally free from negative impact, its benefits outweighed the costs. In contrast, FDI is labelled by the dependency theory as an engine for capital flight (seeAdams 2009 and Chan &Clark 1996). The propagators of dependency theory argue that FDI is capable to undo the course of development through its crowding out effect, especially on the domestic investment. Thus, profits of the foreign firm are sent back to the head office in their home country, which facilitates the capital transfer from the host country.In a related development, four hypotheses have been advanced as a premise to explain the coal consumption-led growth nexus. First, the growth hypothesis asserts that economic progress is driven by coal consumption as supported by Adedoyin et al., (2020) in the BRICS economies. The study shows that coal rent demonstrates a significant negative impact on carbon emission. Other studies (seeBekun *et al.* 2018; Bekun*et al.* 2019) adopted the ARDL bound approach for South Africa and found a cointegration between the series. Further revelation showed that coal consumption is a key driver of economic expansion both in the short- and long- run,confirming that coal usage is an emitter of carbon emission. Apergis and Payne (2010); Ziramba (2009); World-Rufael (2010), (2009), (2007), (2004);Yuan *et al.*(2007); Shui and Lam (2004) also lent their support to this assertion. Conservative hypothesis,on the other hand, posits that demand for

coal is a derivative of economic growth (see Govindaraju and Tang 2013; Zhang and Xu 2012; Jinke*et al.* 2008;Reynolds and Kolodziej 2008; Soytas and Sari 2003). Third, the feedback hypothesis is of the view that the interaction between coal consumption and economic development is a mutual relationship (see: Belke*et al.* 2011; Fuinhas and Marques 2011; World-Rufael 2010; Paul and Bhattacharya 2004; Yuan *et al.* 2008). The neutrality hypothesis asserts that the impact of coal consumption on economic development is a fallacy (see: Ziramba 2009;Jinke*et al.* 2008; Lee and Chang 2005; Sari and Soytas 2004; Yang 2000). Thus, from a policyperspective, hypotheses one and four support the conservation policy which encourages a reduction incoal consumption, whereas hypotheses three and two assert that conservation policy is harmful to economic growth.

3. Materials and Method

To investigatethe causal relationship between the series, the studyused time series data from the World Bankdatabase ranging from 1970 to 2017. The series includes real GDP as a proxy for economic expansion, FDI net inflow (% of GDP), urbanization (URB) represent the urban population as % of the total, and coal consumption which represents the value of coal in tonnes, and carbon emission (CO_2). All series were converted to their log form to ascertain the growth rates of the series. The econometric procedure of this study consists of first, the unit root test for which the order of integration is determined in other to avoid estimationof a regression line that is spurious. Second, the estimation of cointegration to determine if a disturbance in the short is corrected in the long-run using ARDL boundstesting procedure. Finally, we use the dynamic T-Y Granger causality test to determine the causal interaction between the variables of interest.For brevity, the bounds test to cointegration is presentedbriefly after the model specification.

3.1 Model Specification

The relationship establishes that carbon emission is a function of economic expansion (GDP), foreign direct investment (FDI) inflows, coal consumption and industrialization. Thus, the functional form of the model is expressed as:

$$CO_2 = f(GDP, FDI, COAL, URB) \quad (1)$$

$$LnCO_2 = \beta_0 + \beta_1 LnGDP + \beta_2 LnFDI + \beta_3 LnCOAL + \beta_4 LnURB + \mu_t \quad (2)$$

Where, β_0 is the model intercept, while $\beta_1, \beta_2, \beta_3$ and β_4 connote the coefficient of RGDP, FDI, Coal consumption and Industrialization.

ARDL Bounds Testing to Cointegration

This study adopts the ARDL bound testing to cointegration developed by Pesaran *et al.* (2001) due to its dynamic nature. The ARDL procedure remains indifferent irrespective of the order of integration of the series under investigation. This implies that either the order of integration is I(1), I(0), or a mixture of both, the adoption of ARDL still remain valid for the purpose of analysis. Thus, the formulais presented as:

$$\Delta Z = \mu_0 + \mu_1 t + \lambda_1 \delta_{t-1} + \sum_{i-1}^{k} \delta_1 \nu_{it-1} + \sum_{j-1}^{n} \varphi_j \Delta Z_{t-j} + \sum_{i-1}^{k} \sum_{j-1}^{n} \phi_{ij} \Delta V_{it-j} + \Upsilon D_t + \mu_t \qquad (3)$$

Where v_t estimate vector and D account for an exogenous variable which is the structural break within the study scope. The empirical hypothesis of the bound using f-statistic is stated below:

$$H_0 : \lambda_1 = \lambda_2 = \ldots. = \lambda_{K+2} = 0$$
$$H_1 : \lambda_1 \neq \lambda_2 \neq \ldots. \neq \lambda_{K+2} \neq 0$$

Thus, the rejection of H_0 indicates evidence of long-run convergence between the series and vice versa.

4. Preliminary results

The preliminary analysis begins with a graphical technique to show the trend of the series as presented in Figure 1. This is closely followed by the summary statistics which show GDP relatively exhibits the highest average. The probability of the Jargue-Bera test for three of five variables is significant, concluding that the variables arenot normally distributed. The Pearson coefficient correlation matrix (see Table 2) on the other hand reveals the outcomeis in line with empirical intuitions. For instance, there is a very strong interaction between CO_2 and coal consumption, which is not far from the empirical assertion that the latter is a majoremitter of the former. Another significant relationship exists between urbanization and GDP indicating that the former is a driver of the latter and vice versa. The results further show that coal consumption

strongly correlates with GDP which confirms the growth hypothesis. Thus, on the overall, the result shows a strong positive link between the series. The stationarity test from Augmented Dickey-Fuller (ADF) test presented in Table 3 shows that all variables are stationary at level— at different statistical significance except for GDP. The same is applicable to the Phillips-Perron (PP) test. However, for ADF and PP unit root test, it is established at first difference that all series turn out to be stationary at a 1% significance level except urbanization. The exceptional revelation here is that urbanizationis stationary at level form but turns non-stationary at first difference. This could be due to variation or drift characteristic of time series data noted by Gujarati (2009). In addition, only GDP fails to be stationary at level butturns stationary at first difference. The result shows a different order of integration which suggest the adoption of the autoregressive distributed lag (ARDL)bound test as the most suitable method.

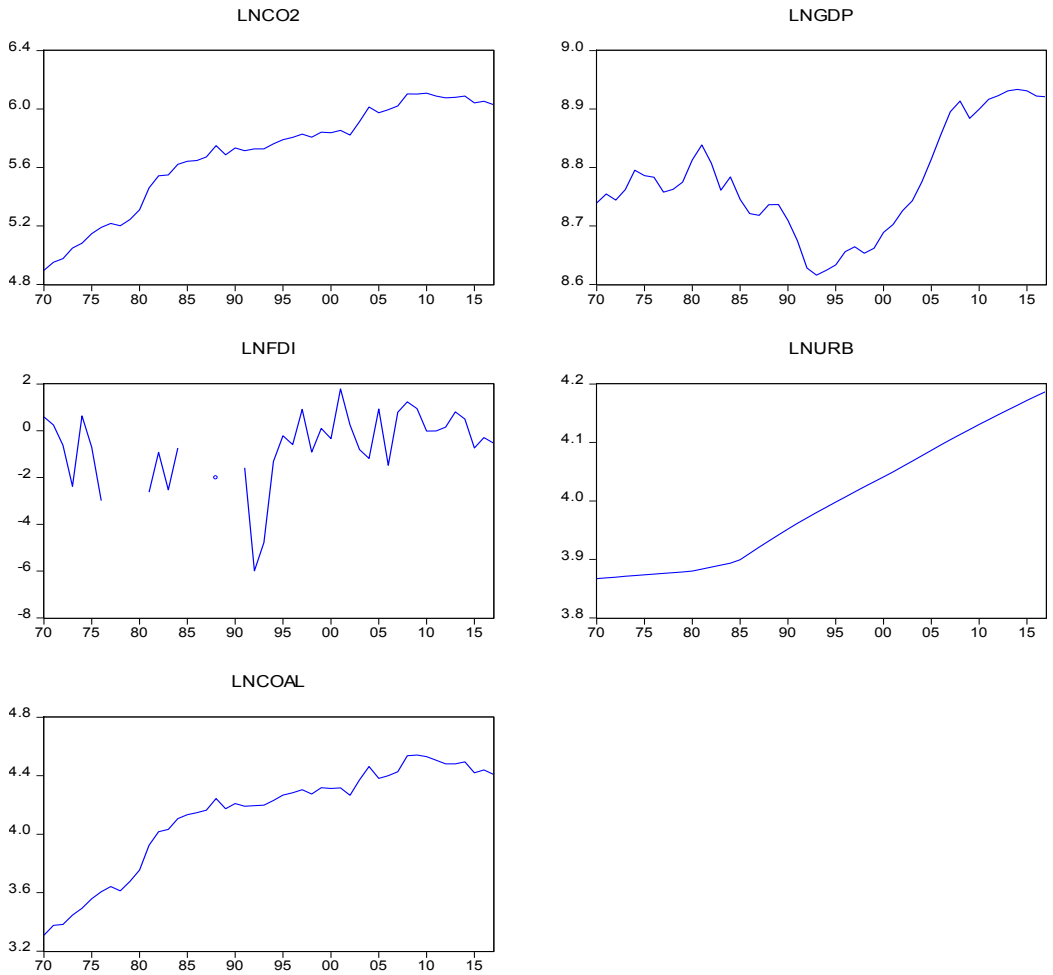

Figure 1: Visual graph of the variables

Table 1: Summary Statistics

	LNCO2	LNGDP	LNFDI	LNURB	LNCOAL
Mean	5.728704	8.781534	-0.676924	4.016755	4.167526
Median	5.821883	8.775257	-0.526894	4.024101	4.282794
Maximum	6.107774	8.933624	1.788230	4.187379	4.541417
Minimum	4.896834	8.615685	-5.993135	3.867214	3.308790
Std. Dev.	0.368005	0.103445	1.585520	0.108153	0.370087
Skewness	-1.024367	0.057322	-1.364664	-0.055998	-1.205243
Kurtosis	2.846857	1.755786	5.297031	1.644816	3.122840
Jarque-Bera	6.858735	2.536968	20.67908	3.004735	9.466494
Probability	0.032407	0.281258	0.000032	0.222603	0.008798
Sum	223.4195	342.4798	-26.40005	156.6534	162.5335
Sum Sq. Dev.	5.146245	0.406631	95.52715	0.444486	5.204650
Observations	39	39	39	39	39

Note: Natural logarithm of variablesare presented

Table 2: Pairwise correlation matrix analysis

Observations	CO2	GDP	FDI	URB	COAL
CO2	1.000000				
t-Statistic	-----				
Probability	-----				
No. of obs.	48				
GDP	0.456030	1.000000			
t-Statistic	3.475360	-----			
Probability	0.0011	-----			
No. of obs.	48	48			
FDI	0.364679	0.228995	1.000000		
t-Statistic	2.656305	1.595514	-----		
Probability	0.0108	0.1174	-----		
No. of obs.	48	48	48		
URB	0.932540	0.578416	0.425519	1.000000	
t-Statistic	17.51691	4.809126	3.189141	-----	
Probability	0.0000	0.0000	0.0026	-----	
No. of obs.	48	48	48	48	
COAL	0.992918	0.368745	0.348250	0.889777	1.000000
t-Statistic	56.68603	2.690554	2.519677	13.22265	-----
Probability	0.0000	0.0099	0.0153	0.0000	-----
No. of obs.	48	48	48	48	48

Note: Series are in their level form

Table 3: Non-stationarity test (ADF and PP)

Statistics (Level)	$LNCO_2$	LNGDP	LNFDI	LNURB	LNCOAL
τ_T (ADF)	-1.142	-1.384	-3.901**	-3.759**	-1.039
τ_μ (ADF)	-3.159**	-0.874	-3.575**	-0.129	-3.165**
τ (ADF)	3.690	0.599	-3.303***	2.009	2.871
τ_T (PP)	-1.075	-1.073	-3.781**	-3.455*	-0.9439
τ_μ (PP)	-3.320**	-0.605	-3.475**	2.252	-3.321**
τ (PP)	3.186	0.855	-3.100***	6.357	2.551
Statistics (FirstDifferc)	LNGDP	LNFDI	LNFDI	LNURB	LNCOAL
τ_T (ADF)	-6.961***	-4.355***	-4.524***	-0.921	-6.867***
τ_μ (ADF)	-6.008***	-4.265***	-8.182***	-1.873	-5.934***
τ (ADF)	-4.895***	-4.253***	-8.305***	-0.129	-5.185***
τ_T (PP)	-6.975***	-4.301***	-8.458***	-0.921	-6.903***
τ_μ (PP)	-6.004***	-4.258***	-8.606***	-1.653	-5.934***
τ (PP)	-4.951***	-4.243***	-8.706***	0.097	-5.205***

Note: significance at ***0.01 and **0.05

Table 4: Lag Length Criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	137.6040	NA	3.52e-10	-7.577374	-7.355182	-7.500673
1	448.7944	515.6868*	2.83e-17*	-23.93111*	-22.59795*	-23.47090*

Source: Author's computation issignificant at ***0.01 and **0.05

The lag length in this study is selected because all the Sequential Modified Likelihood Ratio test statistic (LR, FPE, AIC, SC & HQ) unanimously generated a lag length of one. Thus, lag one is deemed most appropriate for this study since there is no conflicting interest among Sequential Modified Likelihood Ratio test statistic.

5. Empirical Analysis

Table 5 presents the empirical findings from the ARDL long-run and short-run test. The result reveals that economic expansion emits CO_2 significantly both in the long- and short-run. That is about 0.269% of carbon emission in the short-run is a consequence of the growth process in South Africa. The same is true of 0.187% for the long-run. This implies that economic expansion

produces emission as its consequences. The impact of FDI inflows on CO_2 emission is found to be significantly negative in both periods suggesting that FDI inflow rather slow down carbon emission by about 0.002% and 0.005% in the two separate terms. The result further indicates that the contribution of urbanization to CO_2 is positively insignificant in the short-run but turns significant in the long-run. Urbanization significantly contributes to carbon emission by 0.357% in the long-run which has policy implications for South Africa, pointing out that economic activities in the urban centres are in part responsible for carbon emission. This is not far-fetched as activities in urban centres'such as industrial operation are major producers of air pollution (carbon emissions) and water pollution. Thus, the government and stakeholders must partner to devise means of curtailing and efficiently managing the emission produced from economic and commercial activities in the urban centres. A channel for proper disposal of the waste from the sources of emission must be put in place. In a related development, coal consumption contributes significantly positive to carbon emissionsboth in the short- and long-run. About 0.771% of carbon emission in South Africa is attributed to the operation of the coal sector in the short term, while in the distance term coal accounts for about 0.865% carbon emission in the economy. The revelation from this test shows that coal consumption proves to be the highest emitter of CO_2 in South Africa. The implication is that the government must implement a conservation policy to lessencarbon emissions or risk pending danger of environmental degradation. On the other hand, after the rejection of the null hypothesis at 10, 5 and 1 percent, the cointegration bound test as presented in Table 6 reveals that the series converges in the long-run quickly with a high speed of adjustment of ~51%, as established by the error correction term (ECT). This implies that the short-run disturbance between the series could be corrected in the nearest future. The diagnostic test as presented in part B of Table 5 reveals that the functional model of the study is free from model specification errors. The CUSUM and CUSUMSQ presented in Figure 2 and 3 indicate that the model is stable — as the blue line is properly fitted into the critical boundary (Emire & Bekun, 2019; Okunola ,2016).

Table 5: ARDL result CO_2=f(GDP,FDI,URB, COAL)

Variables	Coefficient	SE	t-statistic	P-Value
Short-run				
LNGDP	0.269***	0.062	4.339	0.000
LNFDI	-0.002**	0.001	-2.646	0.013
LNURB	0.934	1.260	0.741	0.465
LNCOAL	0.771***	0.027	28.616	0.000
ECT	-0.512***	0.085	-5.998	0.000
Long run				
LNGDP	0.187***	0.044	4.299	0.0002
LNFDI	-0.005**	0.002	-2.596	0.0147
LNURB	0.357***	0.068	5.232	0.0000
LNCOAL	0.865***	0.022	40.003	0.0000
Diagnostic Tests				
Tests	F-statistic	Prob. Value		
χ^2 *SERIAL*	1.189	0.320	F(2,27)	
χ^2 *WHITE*	1.406	0.236	F(8,29)	
χ^2 *RAMSEY*	0.027	0.974	F(2,27)	

Note: ***,** and * represent 1, 5 and 10 percent respectively.

Table 6: ARDL Bounds test

Test stat.	Value	K
F-stat	5.114	4
Critical Value Bounds		
significance	I(0) Bounds	I(1) Bounds
10%	2.427	3.395
5%	2.893	4.000
1%	3.967	5.455

Source**:** Author computation

The results from the TY Granger causality test in Table 7 reveal a one-way link only from GDP to CO_2 emission as supported by Govindaraju and Tang (2013) in the case of China. Furthermore, for the case of South Africa, the uni-directional causality running from economic expansion to pollutant emission is indicative to government officials of South Africa, as the result show economic expansion is pollutant emission driven. This implies that economic growth in South Africa still exhibits the scale effect of growth trajectory, where the emphasis is on economic growth relative to the quality of the environment (Shahbaz and Sinha, 2019). As a matter of urgency, the government must review the consumption of carbon emitters such as coal

—a critical factor in itsgrowth equation to devise means of effective and efficient management, otherwise, the growth process may turn out to mar the economy in the long-run. The findings uncovered a one-way link running from FDI inflows to CO_2 implying that the major types of FDI flowing to South Africa drives CO_2. The empirical evidence proves a one-way interaction flowing from urbanization to CO_2. This is intuitively valid because urbanization connotes explosion of population and commercial activities. Commercial activities which include high industrial productivityare most at time energy-intensive, hence are not free from carbon emissions. Another outcome from the findings also shows that a unidirectional link exists only from economic prosperity to FDI inflows. It signifies that the market size (economic expansion) in South Africa to a greater extent is responsible for the attraction of FDI inflows into the economy. This empirical evidence reflects the true nature of the South African economy which is known to be among the fast-emerging economies inAfrica. Thus,the policy makers and the stakeholders need to do more on promoting the course of economic advancement, as well as, a stable macroeconomic environment to accommodate more FDI inflows and to provide a large market for their finished products. In addition, a peaceful environment in South Africa is not negotiable if the government is determined to give priority to the attraction of new investors into the economy, because no successful investor will risk itsresourcesin an unstable economic or political environment. Similarly, a bidirectional interaction exists between coal consumption and CO_2, whereas only one-way drive connects from GDP to coal consumption. This means that coal consumption in South Africa influences significantly to carbon emissions but noteconomic progress, contradicting the work of Bekun *et al.* 2018 and Bekun*et al.* 2019 for South Africa but supports the conservation hypothesis and other empirical studies (see: Zhang & Xu 2012; World-Rufael 2010). The implication is that conservation policy will be suitable for the South African economy without any side-effect. A bidirectional relationship between GDP and urbanization implies that infrastructure and the general development of urban centres will be a thing of the past in the face of economic prosperity and vice versa. Another mutual benefit exists between urbanization and coal consumption. Notably, urbanization implies population explosion coupled with the expansion of productive economic activities which will, in turn, generate higher demand for energy for power supply. Thus, the reality of improving urban centres through infrastructural development will lead to an influence derived demand for coal consumption through energy generation for power supply. The opposite holds when more energyis demanded. This is so

because energy consumption is a critical factor that drives every segment of the economy. Adequate energy supply will not just boost industrial productivity but will increase the efficiency of the national economic productivity which transcends to improving lives and wellbeing. Finally, the findings further reveal a two-way interaction between FDI inflows and urbanization confirming the economic intuition that urbanization is an active player in attracting FDI inflows as validated by Nielsen *et al.*(2017) and Guimaraes *et al.* (2000). From both business and economic perspective, it can be deduced that functional urban centres with well-developed infrastructure are undoubtedly sight attraction for investors and vice versa, consistent with our *apriori* expectation.

Table 7. Granger block exogeneity results.

Excluded	Chi-sq	df	Prob.
Dependent variable: LNCO2			
LNGDP	170.455***	3	0.0000
LNFDI	161.444***	3	0.0000
LNURB	131.633***	3	0.0000
LNCOAL	25.905***		0.0000
All	776.994***	12	0.0000
Dependent variable: LNGDP			
LNCO2	2.732	3	0.434
LNFDI	5.762	3	0.124
LNURB	36.109***	3	0.000
LNCOAL	2.837	3	0.418
All	126.107***	12	0.000
Dependent variable: LNFDI			
LNCO2	3.967	3	0.265
LNGDP	9.588**	3	0.022
LNURB	7.759**	3	0.051
LNCOAL	4.546	3	0.208
All	49.526***	12	0.000
Dependent variable: LNURB			
LNCO2	1.394	3	0.7070
LNGDP	10.462**	3	0.0150
LNFDI	7.784**	3	0.0507
LNCOAL	3.992	3	0.2624
All	249.016***	12	0.0000
Dependent variable: LNCOAL			
LNCO2	17.437***	3	0.000
LNGDP	74.545***	3	0.000
LNFDI	79.077***	3	0.000
LNURB	58.793***	3	0.000
All	283.716***	12	0.000

Note: significance at ***0.01 and **0.05

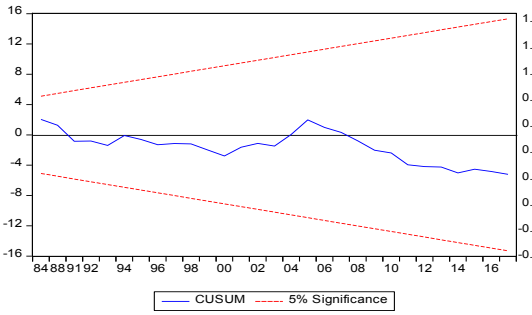

Figure 2: CUSUM

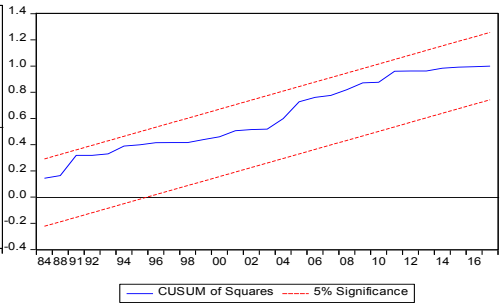

Figure 3: CUSUMSQ

6. Conclusion

This study estimated the causal relationship between FDI inflows and economic advancement in South African by incorporating urbanization, coal consumption carbon emission as additional variables, with specific emphasis on the role of urbanization. The results from the findings through granger causality show that FDI does not drive economic advancement in South Africa, contradicting our a priori expectation. FDI was found to significantly hamper carbon emissions both in the short- and long- run, implying that FDI inflows to South Africa contribute to economic expansion through its positive impact on environmental quality. This call for the attention of the authorities concern to take drastic and urgent measures for promoting the inflowsof FDI into the economy. The stakeholders and managers of the economy must ensure thatmore FDI is allowed to flow into the country in other to achieve long-run economic acceleration through improvement in the environment. To this end, the authority concern could motivate new foreign investors through strategic and business incentives such as a free license for operation and stability of the domestic currency. Furthermore, economic expansion promotes carbon emissions both in the short- and long- run, which implies that the growth path of the economy poses a great danger to its economic acceleration. The government must explore all possible ways to regulate the use of factors responsible for emissions in the economy among which is coal consumption. Economic growth must be monitored closely to avoid reversal reaction in future. The findings showed that urbanization is a non-significant driver of carbon emissions in the short-run but turned significant in the long-run. In reality, urbanization connotes

explosion in both population and commercial activities which industrialization is an integral part, thus, not surprising to confirm it as an emitter. This is a pointer that the authorities concern must put in place workable strategies to curb excess urban activities such as proper discharge of industrial pollutions, setting up of industrial zone away from human settlement. Similarly, the findings from the granger causality show a two-way drive between urbanization and FDI inflows, implying that urban development in South Africa plays a vital role in promoting the course of FDI inflow into the economy. The government of South Africa must be guided by this evidence in placing priorities in terms of resource allocation. Both attention and adequate resources must be shifted to promote the course of urban development toattract significant FDI into the economy. The government of the day must embark on strategic policies such as sitting of the industrial zone and embarking on infrastructureimprovement as a matter of necessity.On the other hand, a one-way link running from GDP to coal consumption is consistent with the conservative hypothesis. Similarly, the bidirectional link between coal consumption and CO_2 suggests that the former is an emitter. The empirical reality from this study speaks volume,showing that coal consumption promotes CO_2emissions but not economic growth. Thus, embarking on effective conservation policy is not optional in the quest of South Africa to achieve economic prosperity and maintain a dynamically healthy economy. Conclusively, urgent priority must be given to conservative policy to avoid the reality of the impending environmental degradation through incessant carbon emission.This is instructive, however, care must be taken to manage the usage of the carbon emitters such as coal, FDI, urban development and economic prosperity. Because economic growth itself is an emitter, attention must be drawn to the necessary measures that will efficiently and effectively managethe path of economic prosperity, otherwise, in the long-run,economic advancement itself will turn out to be a curse rather than blessing through environmental degradation caused by emissions.

References

Abbes, S. M., Mostéfa, B., Seghir, G., &Zakarya, G. Y. (2015). Causal interactions between FDI, and economic growth: evidence from dynamic panel co-integration. *Procedia Economics and Finance*, *23*, 276-290.

Adedoyin, F. F., Gumede, I. M., Bekun, V. F., Etokakpan, U. M., &Balsalobre-lorente, D. (2020). Science of the Total Environment Modelling coal rent, economic growth and CO 2 emissions: Does regulatory quality matter in BRICS economies? Science of the Total Environment, 710, 136284. https://doi.org/10.1016/j.scitotenv.2019.136284

Abdouli, M., &Hammami, S. (2017). The impact of FDI inflows and environmental quality on economic growth: an empirical study for the mena countries. *Journal of the Knowledge Economy*, *8*(1), 254-278.

Adams, S. (2009). Foreign direct investment, domestic investment, and economic growth in Sub-Saharan Africa. Journal of policy modeling, 31(6), 939-949.

Adedoyin, F. F., Gumede, M. I., Bekun, F. V., Etokakpan, M. U., &Balsalobre-lorente, D. (2019). Modelling coal rent, economic growth and CO2 emissions: Does regulatory quality matter in BRICS economies?.*Science of The Total Environment*, 136284.

Alfaro, L., Chanda, A., Kalemli-Ozcan, S., &Sayek, S. (2004). FDI and economic growth: the role of local financial markets. *Journal of international economics*, *64*(1), 89-112.

Almfraji, M. A., &Almsafir, M. K. (2014). Foreign direct investment and economic growth literature review from 1994 to 2012. Procedia-Social and Behavioral Sciences, 129, 206-213.

Alola, A. A., &Alola, U. V. (2019). The dynamic nexus of crop production and population growth: housing market sustainability pathway. *Environmental Science and Pollution Research*, *26*(7), 6472-6480.

Alvarez-Herranz, A., Balsalobre-Lorente, D., Shahbaz, M., & Cantos, J. M. (2017). Energy innovation and renewable energy consumption in the correction of air pollution levels. *Energy Policy*, *105*, 386-397.

Apergis, N., & Payne, J. E. (2010). Coal consumption and economic growth: Evidence from a panel of OECD countries. *Energy Policy*, *38*(3), 1353-1359.

Ayanwale, A. B. (2007). FDI and economic growth: Evidence from Nigeria.

Azman-Saini, W. N. W., Law, S. H., & Ahmad, A. H. (2010). FDI and economic growth: New evidence on the role of financial markets. *Economics letters*, *107*(2), 211-213.

Balcilar, M., Ozdemir, Z. A., & Shahbaz, M. (2019). On the time-varying links between oil and gold: New insights from the rolling and recursive rolling approaches. *International Journal of Finance & Economics*, *24*(3), 1047-1065.

Balsalobre-Lorente, D., Shahbaz, M., Roubaud, D., &Farhani, S. (2018). How economic growth, renewable electricity and natural resources contribute to CO2 emissions?.*Energy Policy*, *113*, 356-367.

Bekun, F. V., Emir, F., &Sarkodie, S. A. (2019). Another look at the relationship between energy consumption, carbon dioxide emissions, and economic growth in South Africa. *Science of the Total Environment*, *655*, 759-765.

Belloumi, M. (2014). The relationship between trade, FDI and economic growth in Tunisia: An application of the autoregressive distributed lag model. Economic systems, 38(2), 269-287.

Belloumi, M. (2014). The relationship between trade, FDI and economic growth in Tunisia: An application of the autoregressive distributed lag model. *Economic systems*, *38*(2), 269-287.

Bezuidenhout, H. (2009). A regional perspective on aid and FDI in Southern Africa. *International Advances in Economic Research*, *15*(3), 310-321.

Borensztein, E., De Gregorio, J., & Lee, J. W. (1998). How does foreign direct investment affect economic growth? 1. *Journal of international Economics*, *45*(1), 115-135.

Borensztein, E., De Gregorio, J., & Lee, J. W. (1998). How does foreign direct investment affect economic growth?.*Journal of international Economics*, *45*(1), 115-135.

Chakraborty, C., &Nunnenkamp, P. (2008). Economic reforms, FDI, and economic growth in India: a sector level analysis. *World development*, *36*(7), 1192-1212.

Clark, C., & Chan, S. (1996). MNCs and developmentalism: Domestic structures as an explanation for East Asian dynamism. In *Foreign Direct Investment in a Changing Global Political Economy* (pp. 84-103). Palgrave Macmillan, London.

Emir, F., &Bekun, F. V. (2019). Energy intensity, carbon emissions, renewable energy, and economic growth nexus: new insights from Romania. Energy & Environment, 30(3), 427-443.

Fedderke, J. W., &Romm, A. T. (2006). Growth impact and determinants of foreign direct investment into South Africa, 1956–2003. *Economic Modelling*, *23*(5), 738-760.

Flora, P., & Agrawal, G. (2014). Foreign direct investment (FDI) and economic growth relationship among highest FDI recipient Asian economies: A panel data analysis. *International Business Management*, *8*(2), 126-132.

Govindaraju, V. C., & Tang, C. F. (2013). The dynamic links between CO2 emissions, economic growth and coal consumption in China and India. *Applied Energy*, *104*, 310-318.

Guimaraes, P., Figueiredo, O., & Woodward, D. (2000). Agglomeration and the location of foreign direct investment in Portugal. *Journal of Urban Economics*, *47*(1), 115-135.

Gungor, H., &Katircioglu, S. T. (2010). Financial development, FDI and real income growth in Turkey: an empirical investigation from the bounds tests and causality analysis. Actual Problems of Economics, 11(114), 215-225.

Güngör, H., Katircioglu, S., &Mercan, M. (2014). Revisiting the nexus between financial development, FDI, and growth: New evidence from second generation econometric procedures in the Turkish context. ActaOeconomica, 64(1), 73-89.

Goh, S. K., Sam, C. Y., & McNown, R. (2017). Re-examining foreign direct investment, exports, and economic growth in asian economies using a bootstrap ARDL test for cointegration. Journal of Asian Economics, 51, 12-22.

Hermes, N., &Lensink, R. (2003). Foreign direct investment, financial development and economic growth. *The Journal of Development Studies*, *40*(1), 142-163.

Jinke, L., Hualing, S., &Dianming, G. (2008). Causality relationship between coal consumption and GDP: difference of major OECD and non-OECD countries. *Applied Energy*, *85*(6), 421-429.

Joshua, U. (2019). An ARDL Approach to the Government Expenditure and Economic Growth Nexus in Nigeria. *Academic Journal of Economic Studies*, *5*(3), 152-160.

Joshua, U., &Bekun, F. V. (2020). The path to achieving environmental sustainability in South Africa: the role of coal consumption, economic expansion, pollutant emission, and total natural resources rent. *Environmental Science and Pollution Research*, 1-9.

Joshua, U., Bekun, F.V. &Adedoyin, F.F. Modeling the nexus between coal consumption, FDI inflow and economic expansion: does industrialization matter in South Africa?.*Environ SciPollut Res* (2020) doi:10.1007/s11356-020-07691-x

Kalai, M., &Zghidi, N. (2019). Foreign direct investment, trade, and economic growth in MENA countries: empirical analysis using ARDL bounds testing approach. *Journal of the Knowledge Economy*, *10*(1), 397-421.

Khobai, H., Hamman, N., Mkhombo, T., Mhaka, S., Mavikela, N., &Phiri, A. (2017). The FDI-growth nexus in South Africa: A re-examination using quantile regression approach

Kumar, N., & Pradhan, J. P. (2002). FDI, externalities and economic growth in developing countries: Some empirical explorations and implications for WTO negotiations on investment. *RIS Discussion Paper*, (27).

Lee, C. C., & Chang, C. P. (2005). Structural breaks, energy consumption, and economic growth revisited: evidence from Taiwan. *Energy Economics*, *27*(6), 857-872.

Li, X., & Liu, X. (2005). Foreign direct investment and economic growth: an increasingly endogenous relationship. *World development*, *33*(3), 393-407.

Li, X., & Liu, X. (2005). Foreign direct investment and economic growth: an increasingly endogenous relationship. *World development*, *33*(3), 393-407.

Mehic, E., Silajdzic, S., &Babic-Hodovic, V. (2013). The impact of FDI on economic growth: Some evidence from southeast Europe. *Emerging Markets Finance and Trade*, *49*(sup1), 5-20.

Mah, J. S. (2010). Foreign direct investment inflows and economic growth of China. Journal of Policy Modeling, 32(1), 155-158.

Nair-Reichert, U., &Weinhold, D. (2001). Causality tests for cross-country panels: a New look at FDI and economic growth in developing countries. Oxford bulletin of economics and statistics, 63(2), 153-171.

Nair-Reichert, U., &Weinhold, D. (2001). Causality tests for cross-country panels: a New look at FDI and economic growth in developing countries. *Oxford bulletin of economics and statistics*, *63*(2), 153-171.

Nielsen, B. B., Asmussen, C. G., &Weatherall, C. D. (2017). The location choice of foreign direct investments: Empirical evidence and methodological challenges. *Journal of World Business*, *52*(1), 62-82.

Nistor, P. (2014). FDI and economic growth, the case of Romania. *Procedia Economics and Finance*, *15*, 577-582.

Omri and Kahoulib, (2013). Causal relationships between energy consumption, foreign direct investment and economic growth: Fresh evidence from dynamic simultaneous-equations models, 67(2014) 913-922.

Omri, A., Nguyen, D. K., &Rault, C. (2014). Causal interactions between CO2 emissions, FDI, and economic growth: Evidence from dynamic simultaneous-equation models. *Economic Modelling*, *42*, 382-389.

Paul, S., & Bhattacharya, R. N. (2004). Causality between energy consumption and economic growth in India: a note on conflicting results. *Energy economics*, *26*(6), 977-983.

Pandya, V., &Sisombat, S. (2017). Impacts of Foreign Direct Investment on Economic Growth: Empirical Evidence from Australian Economy. International Journal of Economics and Finance, 9(5), 121.

Reynolds, D. B., &Kolodziej, M. (2008). Former Soviet Union oil production and GDP decline: Granger causality and the multi-cycle Hubbert curve. *Energy Economics*, *30*(2), 271-289.
Saidi, S., Shahbaz, M., & Akhtar, P. (2018). The long-run relationships between transport energy consumption, transport infrastructure, and economic growth in MENA countries. Transportation Research Part A: Policy and Practice, 111, 78-95.
Saint Akadiri, S., Bekun, F. V., &Sarkodie, S. A. (2019). Contemporaneous interaction between energy consumption, economic growth and environmental sustainability in South Africa: What drives what?.*Science of the Total Environment*, *686*, 468-475.
Sari, R., &Soytas, U. (2004). Disaggregate energy consumption, employment and income in Turkey. *Energy Economics*, *26*(3), 335-344.
Sarkodie, S. A., &Strezov, V. (2019). Effect of foreign direct investments, economic development and energy consumption on greenhouse gas emissions in developing countries. *Science of the Total Environment*, *646*, 862-871.
Shahbaz, M., Khan, S., & Tahir, M. I. (2013). The dynamic links between energy consumption, economic growth, financial development and trade in China: fresh evidence from multivariate framework analysis. Energy economics, 40, 8-21.
Shahbaz, M., & Rahman, M. M. (2012). The dynamic of financial development, imports, foreign direct investment and economic growth: cointegration and causality analysis in Pakistan. *Global Business Review*, *13*(2), 201-219.
Shahbaz, M., & Rahman, M. M. (2012). The dynamic of financial development, imports, foreign direct investment and economic growth: cointegration and causality analysis in Pakistan. Global Business Review, 13(2), 201-219.
Shahbaz, M., & Sinha, A. (2019). Environmental Kuznets curve for CO2 emissions: a literature survey. Journal of Economic Studies, 46(1), 106-168.
Shahbaz, M., Balsalobre-Lorente, D., & Sinha, A. (2019). Foreign direct Investment–CO2 emissions nexus in Middle East and North African countries: Importance of biomass energy consumption. *Journal of cleaner production*, *217*, 603-614.
Shahbaz, M., Mateev, M., Abosedra, S., Nasir, M. A., & Jiao, Z. (2019). Determinants of FDI in France: Role of Transport Infrastructure, Education, Financial Development and Energy Consumption.
Shiu, A., & Lam, P. L. (2004). Electricity consumption and economic growth in China. *Energy policy*, *32*(1), 47-54.
Sokhanvar, A. (2019). Does foreign direct investment accelerate tourism and economic growth within Europe?.*Tourism Management Perspectives*, *29*, 86-96.
Soytas, U., & Sari, R. (2003). Energy consumption and GDP: causality relationship in G-7 countries and emerging markets. *Energy economics*, *25*(1), 33-37.
Sunde, T. (2017). Foreign direct investment, exports and economic growth: ADRL and causality analysis for South Africa. Research in International Business and Finance, 41, 434-444.
Tshepo, M. (2014). The impact of foreign direct investment on economic growth and employment in South Africa: A time series analysis. Mediterranean Journal of Social Sciences, 5(25), 18.
Wang, M. (2009). Manufacturing FDI and economic growth: evidence from Asian economies. *Applied Economics*, *41*(8), 991-1002.
Wolde-Rufael, Y. (2004). Disaggregated industrial energy consumption and GDP: the case of Shanghai, 1952–1999. *Energy economics*, *26*(1), 69-75.

Wolde-Rufael, Y. (2010). Coal consumption and economic growth revisited. *Applied Energy*, *87*(1), 160-167.
Wolde-Rufael, Y. (2010). Coal consumption and economic growth revisited. *Applied Energy*, *87*(1), 160-167.
Yang, H. Y. (2000). A note on the causal relationship between energy and GDP in Taiwan. *Energy economics*, *22*(3), 309-317.

Yao, S. (2006). On economic growth, FDI and exports in China. *Applied Economics*, *38*(3), 339-351.

Yuan, J., Zhao, C., Yu, S., & Hu, Z. (2007). Electricity consumption and economic growth in China: cointegration and co-feature analysis. *Energy Economics*, *29*(6), 1179-1191.

Zhang, C., & Xu, J. (2012). Retesting the causality between energy consumption and GDP in China: Evidence from sectoral and regional analyses using dynamic panel data. *Energy Economics*, *34*(6), 1782-1789.

Ziramba, E. (2009). Disaggregate energy consumption and industrial production in South Africa. *Energy Policy*, *37*(6), 2214-2220.