PEOPLE: International Journal of Social Sciences
ISSN 2454-5899

Luciano Gule, 2021

Volume 7 Issue 1, pp. 75-87

Date of Publication: 11th June 2021

DOI- https://doi.org/10.20319/pijss.2021.71.7587

This paper can be cited as: Gule, L. (2021). The Effects of FDI and Economic Growth on CO2 Emissions in SADC. PEOPLE: International Journal of Social Sciences, 7(1), 75-87.

THE EFFECTS OF FDI AND ECONOMIC GROWTH ON CO2 EMISSIONS IN SADC

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Abstract

This study investigates the effects of foreign direct investment (FDI), economic growth, and capital stocks on the CO2 emissions in 16 Southern African Development Community (SADC). The analysis includes panel data from 1990 to 2014. To examine the effect, both statics and dynamics estimation models were used in this research. The results from panel statics using pooled ordinary least square and dynamic panel estimation using system general methods of the moments suggest a positive and significant effect of FDI and economic growth on CO2 emissions in SADC. While in contrast, capital stocks have negative and significant effects on CO2. These results indicate that FDI inflow has been damaging the environment in SADC countries. While when investing in clean energy the CO2 emissions tend to reduce. Hence, these countries should adopt policies that encourage the use of environmentally friendly technology and keep pursuing sustainable development goals while protecting the environment.

Keywords

CO2 Emission, FDI Inflow, Economic Growth, SADC

1. Introduction

The Southern African Development Community (SADC) comprises emerging economies with rapid economic growth, averaging 4.1 percent from 2012 to 2014. To encourage their integration in the global economy and to increase their economic growth, the SADC like most developing countries, are vigorously seeking foreign direct investment (FDI). During the last twenty years, there has been a significant increase in FDI inflow in the region. Therefore, revitalizing the long debate in the policy and academic sphere about the potentiality of FDI inflow in generating employment opportunities, skills and technology transfer, enhancement of host country competition, and entrepreneurship.

However, the rapid economic growth and the increase in FDI inflow are usually accompanied by an increase in energy consumption. Which can cause unexpected effects on energy resources and the environment in the host countries. FDI inflow has bought many positive aspects to global economies, including SADC countries. The FDI inflow has played a decisive role in the economic transformation and growth of the SADC economy in the last decade. This significance is due to the inflow of capital, technology, and managerial capacity from FDI, which benefited domestic markets. According to OECD (2002), when FDI projects go to host countries, it generates knowledge and innovative capacity through FDI projects. These resources are disseminated not just for the subsidiary but for organizations and people who make up the local technological infrastructure in a rich learning process. Like many least developed countries, which depend on exports of primary goods, the FDI inflow in SADC is accompanied by increasing concern about its impact on the environment.

Although it is well-known that the FDI inflows have brought about positive impacts on the economic growth of many countries (Shaikh, 2010; Choe 2003) the resulting FDI inflows might as well cause environmental damages due to the establishment of foreign subsidiaries that damage the environment through pollution and disforestation. And this leads to global warming, ozone depletion, and acid rain, to name just a few. These FDI inflows projects going to SADC countries in many cases are implemented in a very inefficient way and low cost as much as possible, which usually disregard best environmental practices. Thus, these environmental practices due to the pollution component they may undermine SADC's economic growth and competitiveness. Another critical point is that many SADC countries are low- and middle-income countries and have no means, capital, skills, and technologies to combat pollution caused by FDI projects. And, tackling pollution can be hard and may undermine the development and attractiveness to investors.

Therefore, the importance of FDI, economic growth, and capital stock in SADC and its impact on the environment require a comprehensive study of the aspects affecting it. And, require suitable approaches and policies to be introduced to improve FDI inflow attraction and sustainable growth while protecting the environment. Thus, this study will seek to understand the effects of FDI inflow, economic growth, and capital stock on CO2 emissions in SADC. Previous research on FDI and economic growth mostly centered their attention on benefits in terms of employment generation and transfer of technology from developed to developing countries (Asiedu, 2006 and Quazi, 2007). However, a limited quantity of research has focused on understanding FDI inflow, economic growth, and capital stock and its impact on CO2 emissions in the SADC countries.

2. Literature Review

In this part we are going to outline the previous conducted studies about the link between CO2 emissions, economic growth and FDI in developing countries.

Theoretical links between economic growth and FDI inflow can be traced back to early neoclassical growth models. This points out that FDI inflow in host countries may increase capital stock and promote economic growth and development. In the endogenous growth models, the technological skills brought by FDI inflow can positively impact the economic growth both short and long-run. Many recent studies are consistent with these traditional theories regarding the primary idea that FDI inflow is assumed to impact positively the economic growth in the host countries.

The study by Makki and Somwaru (2004) points out that the inflow of FDI has a positive and significant impact on economic growth as well as exports in host countries. Similarly, research by Almfraji and Almsafir (2014) found that in general FDI inflow tended to have a positive and significant effect on host countries' economic growth. In a few cases, the authors found negative or null effects. They found that trade regimes, a satisfactory level of human capital, and well-structured financial markets were vital elements to correlate positively economic growth and FDI inflow. Acharyya (2009) found that FDI inflow drove the implementation of new knowledge in the production process through capital spillovers. And that the FDI inflow inspired knowledge transfers, both in job training and technology acquisition. Bengoa and Sanchez-Robles (2003) found that to FDI inflow impact positively, the host countries needed to have a suitable level of political and economic stabilization, liberalized human asset and capital markets. Tsen (2019) studying the determinants of FDI in Malaysia found that FDI and economic growth are closely related. And that FDI was a crucial factor for the economic growth of Malaysia. Dixon & Boswell (1996) found that in the short-run, the FDI inflow tended to impacts positively the economic growth of the host countries. The authors affirmed that in the long run, the dependence on FDI inflow damaged economic growth because the institutions and structure developed with FDI support required FDI inflow. Kendirli et al. (2017) using granger causality analysis found no causal relationship between FDI and economic growth in Turkey.

The issue of FDI inflow and environmental degradation has received increased attention recently. And, some studies have been analyzing the interlinks between FDI inflow, environment, and trade in developing countries. In SADC member states, many FDI projects are being criticized for hurting the environment, even when they are not in some cases. Such apprehensions have increased in line with the increasing FDI inflow to host and low-income countries.

Omoju (2014) points out that FDI inflow impact on CO2 emission was more severe in the in-host countries which depended on natural resource extraction; because they caused health problems, death, and disabilities. For the author, high-income countries have capital, technologies, and resources to combat it. Consequently, they had fewer health risks, less impact on climate change, and fewer efforts to decrease pollution caused by CO2 emissions. According to OECD (2002), some FDI inflow costs include environmental impact (disforestation, global warming, ozone depletion, acid rain). Frankel and Rose (2005) researching the impact of trade openness on the environment found that the impact was positive and significant in countries with a less capital-labor ratio below the global average of per capita income.

Demena et al. (2020) point out that environmental damage may increase due to the inflow of FDI in the long run. According to the authors, this relationship is called the Environment Kuznets curve, an inverted U-relationship between the level of pollution and the production of economic growth. Dean (1999) affirms that economic growth may positively affect the environment in the long run if host countries change the demand to use cleaner goods. There is no doubt empirically and theoretically that higher levels of CO2 emissions reduce the productive capacity of a country and have a negative impact on climate change. Grossman and Krueger (1991), analyzing the relationship between economic growth and air quality found that the global impact of CO2 provided little motivation for both low-income and high-income countries to implement unilateral actions to reduce carbon emissions. Regarding capital stocks, Rauscher (1999) found an ambiguous effect on the optimal level of deposition of toxic waste. For the author, this would be a case even in a simple model without production's external effects. The study concluded by saying that an additional unit of capital, raised the productivity of emissions by the same amount. Therefore, the consumption set; on the other hand, the increase in consumption led to a reduction in consumption's marginal utility.

3. Methodology

In this part we will be presenting the methods used to conduct the research, how the data was collected, as well as the procedures used to estimate the main equation.

3.1 Method and Data

The cobb-Douglas production function is used to examine the effect of the FDI inflow, economic growth, and capital stock on carbon emissions. In this method, the GDP depends on FDI inflows, capital stocks, and CO2 emissions. This study uses both static and dynamic panel data models, which are estimated using pooled ordinary least square on static panel data. To estimate the dynamic panel data, we use the difference (diff) and system (sys) generalized methods of moments (GMM). Thus, this research aims to use the Cobb Douglas production function approach to estimate the impact of FDI inflows and economic growth on CO2 emissions in SADC countries.

Cobb-Douglas production functions include K and L as additional production factors. In the production function, income relies on energy consumption and is directly linked to emissions of CO2. Also, we included FDI inflow in the production function to understand its impact on economic growth. Thus, in this study, we consider a Cobb-Douglas production function as below:

$$Y = e^{\varepsilon} A K^{\alpha} E^{\lambda} (FDI)^{\Psi} L^{\beta} \ . (1)$$

Where Y = indicates the real GDP, A = total factor productivity, K = capital stock, E = energy consumption, L indicates the labor force, and ε = the stochastic term. α, λ, Ψ, β, is the production elasticities with respect to domestic capital, energy consumption, FD, and labor force, respectively.

This model considers that FDI inflow and energy consumption are vital inputs to produce the general output. Pereira and Pereira (2010) "point out that at a defined point in time, there is a direct linear relationship between FDI inflow and carbon emissions when the technology level is provided CO2 emissions and energy consumption, such as E=*b*CO2". (Pereira and Pereira, 2010). Hence, the equation new expression is derived as:

$$Y = b^{\lambda} e^{\varepsilon} A K^{\alpha} CO_2^{\lambda} (FDI)^{\Psi} L^{\beta}. \ (2)$$

Then, both sides of equation (2) are divided by Population (L) to obtain GDP per capita, and assuming that Cob Douglas production function exhibit constant return to scale $\alpha + \lambda + \Psi + \beta = 1$. After this arrangement, we get

$$\frac{Y}{L} = b^{\lambda} e^{\varepsilon} A \left(\frac{K}{L}\right)^{\alpha} \left(\frac{CO_2}{L}\right)^{\lambda} \left(\frac{FDI}{L}\right)^{\Psi} . (3)$$

The above Cob Douglas production can be written in a log-linear form as described below

$$log\left(\frac{Y}{L}\right) = log\left(b^{\lambda} A\right) + \alpha log\left(\frac{K}{L}\right) + \lambda log\left(\frac{CO_2}{L}\right) + \Psi\left(\frac{FDI}{L}\right) + \varepsilon, (4)$$

Let $a = \log\left(b^{\lambda} A\right)$, we have

$$log\left(\frac{Y}{L}\right) = a + \alpha log\left(\frac{K}{L}\right) + \lambda log\left(\frac{CO_2}{L}\right) + \Psi\left(\frac{FDI}{L}\right) + \varepsilon, (5)$$

Equation (5) can be rewritten in the form of growth and panel data as

$$g\left(\frac{Y}{L}\right)_{it} = a + \alpha_{1t} g\left(\frac{K}{L}\right)_{it} + \lambda_{2t} g\left(\frac{CO_2}{L}\right)_{it} + \Psi_{3t} g\left(\frac{FDI}{L}\right)_{it} + \varepsilon_{it}. (6)$$

In equation 6, $i = 1, \ldots, N$ stand for the countries (N is 16 countries), $t = 1$, t stands for the period and $g\left(\frac{Y}{L}\right)$ indicates GDP per capita growth rates, $g\left(\frac{K}{L}\right)$ Denotes capital stocks growth rates. $g\left(\frac{CO_2}{L}\right)$ Denotes the growth rate of per capita CO2 emissions in metric tons. And $g\left(\frac{FDI}{L}\right)$ The growth rate of FDI inflow per capita and ε is our stochastic term.

Using the below equation (7), we investigate the impact of FDI inflow, GDP, and K on carbon emissions.

$$g\left(\frac{CO_2}{L}\right)_{it} = \beta_0 + \beta_{1i} g\left(\frac{FDI}{L}\right)_{it} + \beta_{2i} g\left(\frac{Y}{L}\right)_{it} + \beta_{3i} g\left(\frac{K}{L}\right)_{it} + \beta_{4i} FD_{i,t} + \beta_{5i} POP_{i,t} + \beta_{6,i} OPN_{i,t} + \varepsilon_{it} (7).$$

Equation (7) hypothesizes that the FDI inflow, GDP and K, can influence CO2 emissions; also, in our equation, we use financial development (FD) and Population growth (POP) and trade openness are treated (OPN) as instrumental variables (IVs).

3.2 Estimation Procedures

Static and dynamic panel estimation techniques were used in this study. For the static panel, we use Pooled OLS. In the dynamic panel data model, we estimate our equation using a GMM which allows the lagged level of CO2 emissions. To resolve the endogeneity problem, the GMM models use a set of instrumental variables (IVs). GMM estimators use two forms of estimation (difference and system), and both can be considered alternatively in their one- and two-step versions. According to Arellano and Bond (1991), the set of IVs of the diff-GMM estimator consists of all the lags available in the difference of the endogenous variables and the strictly exogenous regressors, while the sys-GMM includes not only the previous IVs but also values lags of the dependent variable. And this helps to solve the problem of endogeneity that can arise from the possible correlation between the independent variable and the error term in models that use a dynamic panel. It also permits to deal with omitted dynamics in static panel data models, owing to the ignorance of the impacts of lagged values of the dependent variable.

3.3 Data

This study focused on SADC annual data from 1990 to 2014. This period was chosen based on data availability. Also, because many SADC countries started liberalizing the economy in 1990 and received the first FDI project in the late 1990s. In this research, we used seven variables: namely, GDP (constant \$ 2005) measures economic growth, net FDI inflows (share of GDP); gross fixed capital formation in per capita value (constant \$ 2005) is used as a proxy for the capital stock; Domestic credit to the private sector (in ration to GDP) is used as a proxy for the Financial Development; we used CO2 emissions (metric tons per capita); population growth, and total trade as a proportion of GDP used as a proxy of trade opening. The data was collected from World Development Indicators.

The pollution measure used in this research is the growth of CO2 emissions per capita in metric tons. According to Hoffmann et al.; (2005), CO2 emission, due to its enormous contribution to global warming, is frequently used in recent studies. And, is commonly involved as one of the main variables of concern in international agreements on climate change. Besides, CO2 emission is the only environment-related variable in the SADC member states available consistently from 1990 to 2014. We highlight the growth in CO2 emissions per capita, as there is a possibility that total CO2 emissions are related to population growth. In our equations, we divide all the variables by the total number of the population to obtain per capita variables. Below is table 1, where we show the descriptive statistics.

Table 1: *Descriptive Statistics*

Variables	Mean	Standard deviation	CV	Min	Max
CO2 emission	-0.597	1.458	0.898	-3.557	2.305
GDP per capita (constant 2010 USD)	7.292	1.169	0.160	5.087	9.501
FDI inflow	3.038	2.193	0.722	-7.875	8.846
Capital stocks (constant stocks 2005 USD	-12.464	2.016	-10.448	-16.918	-7.528
Trade Openness (in %)	85.543	38.039	0.445	20.437	225.023
Pop Growth (in %)	2.225	0.951	0.427	-2.629	3.948
Financial development (in %)	18.464	2.233	0.121	9.210	23.014

Notes: CV indicates the coefficient of variation

4. Findings and Discussion

In this research both static and dynamic panel data estimation were used. Therefore, the following part is dedicated to the discussion of the research findings.

4.1 Static Panel Data Estimation Results

To analyze the effect of the inflow of FDI, GDP, and K on CO2 emissions in SADC countries, we considered static panel estimation techniques using Pooled OLS. Table 2 contains the results of the estimated models. The empirical results of pooled OLS show that GDP and FDI inflow are positive and significant on CO2 emissions at 1 and 10 percent levels. The increase of 1.207 denotes that a 1 percent increase in GDP augments CO2 emissions by 1.2 percent. Besides, a 10 percent increase in FDI with a grade of 0.083 suggests a 0.83 percent increase in CO2 emissions. In the Pooled OLS model, the high R-square of 0.78 value explains a strong connection between FDI inflows, GDP, and CO2 emissions. The results mean that 78 percent of the variation in CO2 emissions is explained by economic growth and capital stock. According to these results, economic growth and the inflow of FDI have positive and significant impacts on CO2, while CO2 emission is impacted negatively and significantly by capital stock. The result shows that a 10 percent increase in capital stock reduces CO2 emissions by about 0.11 percent. Therefore, more capital stock might lead to a reduction in CO2 emissions. This is consistent with the theoretical results of Hettich (2000).

Table 2: *Results of Static Estimation*

Independent Variable	*CO2 as Dependent Variable*	
	OLS FE	Pooled OLS
ln(FDI)	0.080*	0.083*
	(0.012)	(0.022)
ln(GDP)	1.019***	1.207***
	(0.092)	(0.045)
ln(K)	0.0426	-0.113*
	(0.041)	(0.023)
Constant	-7.486***	-10.73***
	(0.771)	(0.493)
Observations	350	350
Countries	16	16
R-squared	0.323	0.781

Notes: Standard errors are enclosed in parentheses *, **, and *** designate significance at 10, 5, and 1 percent, respectively.

4.2 Results of Dynamic Panel Estimation

In this research, dynamic panel specifications where lagged CO2 emissions are measured using GMM estimators were also used. The Hansen test rejects the null hypothesis of overidentification restrictions. As a result, the diff-GMM estimate may not be adequate in this situation. Therefore, we estimate the equation using sys-GMM, where both IVs and specification tests are valid. Therefore, we conclude that the sys-GMM estimate is robust and fits the model.

Table 3: *Results of Diff-GMM and Sys-GMM*

Independent variables	Dependent Variable: carbon dioxide emission (CO2)			
	Diff-GMM		Sys-GMM	
Lagged lnCO2_emissions	0.612*	(0.335)	0.865***	(0.068)

lnGDP	0.511	(0.459)	0.128*	(0.074)
lnFDI	0.017	(0.0451)	0.020**	(0.010)
lnCapital Stock	-0.049	(0.0538)	-0.024**	(0.017)
Intercept	-4.612	(4.155)	-1.085***	(0.718)
AR (2) test (*p*-value)	-0.33	0.743	-0.30	0.766
Hansen J-test (*p*-value)	12.99	1.000	12.34	1.000
Observations	326		326	
Number of Countries	16		16	

Notes: Standard errors are indicated in parentheses. *, **, *** designates significance at the level of 10, 5, and 1 percent, respectively.

The results of the sys-GMM estimate in table 3 show that the estimated coefficient of the lagged variable is positive and statistically significant. The result indicates that the lagged value of CO2 emissions in the previous period is positive and statistically significant at a 1 percent level compared to its current value. In this specification, the FDI inflow is positive and statistically significant at the 5 percent level. Showing that the 5 percent increase in FDI inflows augments CO2 emissions by 0.02 percent. Meaning that FDI inflows may have resulted in polluting havens in SADC member states. Denoting that the SADC countries to attract and retain FDI inflow may have reduced environmental regulations. This result is consistent with studies made by Omri et al. (2015) and Pao and Tsai (2010). Besides, we found that the GDP impact on CO2 emission is statistically significant at a level of 10 percent. According to these findings, a 10 percent increase in GDP results in a 0.13 percent increase in carbon emissions. This means that greater economic growth leads to greater emissions. Similar results are obtained by Saidi and Hammami (2015). At the same time, capital stock is found to be negative at 5 percent. The degree of 0.02 indicates that a 5 percent increase in capital stock decreases CO2 emissions in SADC by 0.02 percent.

Using both static and dynamic estimations, we conclude that CO2 emissions in SADC countries are impacted positively and significantly by GDP and FDI inflow. In contrast, capital stocks have a negative and significant impact. Thus, policymakers must consider these situations to design policies favorable to sustainable growth without compromising the environment in SADC countries.

5. Concluding Remarks and Policy Implications

This research examined the effect of FDI inflow, capital stocks, and economic growth on CO2 emissions in SADC countries. The effect of the inflow of FDI, economic growth, and capital stock was measured using data from 16 SADC countries in the period from 1990 to 2014. To properly handle with static panel model, we used Pooled OLS. And in dynamic panel data, we used the system GMM model. The results for both estimation techniques indicated a positive and significant effect of FDI and economic growth on CO2 emissions in SADC countries. Regarding the effect of the capital stock, the study found that it is negative and statistically significant on CO2 emissions. Meaning that, when SADC countries invest more capital in non-polluting advanced technology, CO2 emissions tended to reduce.

Hence, FDI inflow and economic growth are the primary sources of CO2 emissions in SADC countries. The political implication drawn from this research is that economic growth and the inflow of FDI have a positive and significant effect on the Environment. The persistent deterioration of the environment can affect negatively the economy and human health. And in the long run, may decrease productivity in the active working population. Since SADC countries have not reached the Kuznets curve, the turning point of CO2 emissions, these emissions will not stop spontaneously. Thus, SADC countries should maintain reasonable economic growth before reaching the turning point and solve environmental problems. However, the use of efficient technologies should be stimulated to improve local production. FDI inflow projects should be forced to use and share environment-friendly technology. SADC countries must keep on seeking FDI inflow, explore cut-edge technology brought in by FDI, and straighten their cooperation with high-income countries regarding reducing CO2 emissions. Meanwhile, SADC countries should increase environmental policies and augment the use of eco-friendly energy.

In this research, we investigated the impact of FDI and economic growth on CO2 emissions in SADC. Using econometric analyses, we found that CO2 emissions in SADC countries are impacted positively and significantly by GDP and FDI inflow. In this study, we wanted the sample of the study to be more inclusive and contain more time observation. However, due to a lack of capital stock data, we had to change the temporal dimension to include only data from 1990. Also, we faced problems associated with the lack of previous research on FDI and economic growth and their effect on CO2 emissions in SADC. In future studies, researchers may include more independent variables, as well as other African regional blocks using different periods.

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