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FORWARD INTEGRATION INTO GLOBAL VALUE CHAINS AND POLLUTION HAVEN HYPOTHESIS IN SOMALIA

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Abstract:
This study investigates whether Somalia's forward integration into global value chains (GVCs) sets it up as a pollution haven, while controlling for the effects of gross domestic product, renewable energy, urban population and trade openness. Annual time-series data set for the period 1992-2018 is analyzed via dynamic least squares regression analysis. The empirical results show that a percentage rise in the domestic value added of Somalia's exports causes an increase of 0.274% in CO2 emissions. The study outcome therefore reveals that forward integration into global value chains significantly aggravates environmental pollution in the country. This is in confirmation of the study hypothesis that Somalia may be serving as a pollution haven because of the relatively lax environmental policies that permit the inflow of pollution-intensive foreign direct investments. It may also be due to the dominance of primary commodities in its exports which places it at the beginning of the GVC spectrum. A number of policy recommendations are provided.

Keywords:
Somalia, Forward integration, Pollution Haven Hypothesis, Dynamic Least Square (DOLS).

1. Introduction
In recent times, the world economy has experienced a greater level of integration that has led to countries manufacturing goods and services at the lowest opportunity costs (Koźluk & Timiliotis, 2016). As nations increase the level of production of goods and services that are consistent with the amount of labor, capital and entrepreneurship they possess, the production activity also continues to encounter fragmentation into diverse phases of specialization (Baldwin & Yan 2014). This fragmentation of production generates a variety of processes collectively referred to as global value chains (GVCs), where various stages of the production process are located across different countries (Organization for Economic Co-operation and Development [OECD], 2013).
Global value chains are based on the comparative advantage theory developed by Ricardo (1817) which suggests that countries are better off manufacturing goods and services at the lowest opportunity costs. Under global value chains, raw materials serve as the core of a nation's production of goods or inputs, which is processed in another country and further sold to other countries for utilization. The primary objective of GVCs is to increase the effectiveness of the manufacturing and distribution processes by integrating various production stages across numerous nations (Cigna et al., 2022). As a result, businesses can benefit from specialized knowledge, resources and low-cost production (OECD, 2013).
Global value chains participation has been on the increase since the beginning of the 1990s. The main causes are the expansion of technological development in transportation and logistics, as well as the rise of trade openness (Delera, 2021). Currently, global value chains trade accounts for approximately 50% of total world trade (World Development Report, 2020). This increased involvement in GVCs has triggered extraordinary economic convergence, in which developing countries have experienced tremendous growth and are even starting to overtake developed countries (World Development Report, 2020). Developing countries are not only importing elements for finished goods for local sales, but are also exporting resources that are found in the most advanced goods on earth (Taglioni & Winkler, 2014).
Somalia is one of the developing countries that have seized the chance to participate in GVCs. The nation was afflicted by decades of conflict and climate change; however, despite significant challenges, the country is rebuilding

its economic governance institutions. The country is currently focused on introducing and implementing reforms designed to support its efforts towards reaching the Heavily Indebted Poor Countries Initiative Completion Point by the end of 2023 . Consequently, the country's forward integration into GVC participation has been on a steady rise, especially in the 1990s and 2000s. In addition to that, the country recently submitted documents to join the East African Community with the overall aim of enhancing the nation's collective competitiveness in GVCs. This is expected to expose the country to a larger market, enable economies of scale, and attract foreign investment and development for regional value chains. Engaging in GVCs thus stands out as a means through which a developing nation such as Somalia can integrate into the global economy by permitting local firms to participate in international production networks (Kowalski et al., 2015).

Even though many economies have taken advantage of participation in GVCs, fears are building up around the environmental hazards of this cross-border fragmentation of manufacturing procedures (Wiedmann & Lenzen, 2018). GVCs are a part of international trade that plays a massive role in exporting goods that a country produces (Görg & Greenaway, 2004). It has however been established that increased international trade raises environmental pollution (Kivyiro & Arminen, 2014; Asongu & Odhiambo, 2020). Increased international trade is known to affect pollution through technological shifts, factor endowments and composition effects (Vale et al., 2018). As such, while Somalia's participation in GVCs may have positive economic effects, it may also have detrimental environmental consequences. Understanding the environmental consequences of Somalia's integration into GVCs is thus the central theme of this study. The study focuses specifically on Somalia's forward integration into GVCs since most of the country's participation in the international markets is in the form of primary product exports.

To address the potential environmental problems associated with GVC participation, policies that take the negative externality generated into consideration are being introduced (Koźluk & Timiliotis, 2016). These policies however raise the cost of manufacturing by incorporating the costs of these externalities. One of the possible outcomes of this development is that dirty companies may decide to relocate their production processes to countries with relatively lax environmental policies. It is therefore likely that developing nations such as Somalia may experience significant inflows of foreign direct investment by dirty companies trying to decrease costs and avoid high environmental standards (Saussay & Zugravu-Soilita, 2023).

Stemming from the above, an important topic in environmental literature that needs to be examined is whether the relatively lax environmental policies in poor developing countries such as Somalia set the countries up as pollution havens. As stated by the pollution haven hypothesis (PHH), businesses generally attempt to avoid the additional costs imposed by strict environmental policies by moving their production to nations with weaker environmental standards. Developing countries such as Somalia seeking increases in foreign investments often attempt to take advantage of the situation by deliberately keeping environmental regulations weak, the end result being increased pollution in the home nation. Due to this reason, Somalia may be unknowingly receiving investment inflows that finance parts of the GVCs that are pollution-intensive, hence acting as a pollution haven.

Moreover, primary commodities that require relatively minimal processing before exporting dominate Somalia's export baskets. Somalia's exports are therefore predominantly placed at the beginning of the chain in the form of forward integration, since the country's exports mostly serve as inputs for further production processes. Studies however reveal that the extractive and agricultural activities that are found in the primary sector are major causes of environmental damage (Reynolds et al., 2015). For this reason, Somalia's positioning at the beginning of the GVCs may be a major trigger of environmental damage. In other words, the nation's positioning along the chain may be another reason why the country is a pollution haven.

This study specifically investigates whether this is the case in Somalia. It determines whether Somalia's participation in GVCs has led to increased environmental damage for two possible reasons. First, because foreign multinational companies functioning in pollution production shift their businesses to Somalia, and because of these relocations, the nation has become a pollution haven. Second, because Somalia's positioning at the beginning of the GVC spectrum has restricted it to trading in primary commodities that require environmentally unfriendly production processes.

African countries such as Somalia are appropriate territories for examining and evaluating the PHH (Gharnit et al., 2019). Thus, this study adds to the body of knowledge by determining whether Somalia's forward integration into global value chains is making the country a pollution haven. This is the first research to focus on the relationship

between forward integration into GVC and PHH in an East African country (Somalia). The main contribution of this study to literature is that it extends the trade-pollution nexus debate to global value chains participation.
The rest of this research is organized as follows. Section two presents a review of related literature. Section three describes the methodology and data. Section four reports the results of the study, while section five concludes the paper with policies and recommendations.

2. Literature Review

The link between international trade and environment has sparked a heated debate amongst scholars. The link between international trade and the environment is generally examined within the scope of two key hypotheses—the pollution haven hypothesis and pollution halo hypothesis. The pollution haven hypothesis contends that multinational corporations outsource businesses with high pollution levels to places with cheap labor and weak environmental restrictions (Sadik-Zada & Ferrari, 2020). These nations that lack the resources required for economic development instead depend on foreign investments which raise the incentives for them to prioritize economic growth ahead of environmental protection (Musah et al., 2022).
Grossman and Krueger (1995) explain that at the initial stages of economic development, countries experience increased pollution due to the expansion of production. Zhang and Zhou (2016) report that countries that host foreign companies tend to experience an upsurge in economic activities that cause increased environmental pollution if lax environmental policies in the host nations are not strengthened. According to the pollution haven hypothesis, countries with lax environmental policies draw businesses that produce high levels of greenhouse gas emissions (Ali & Gniniguè, 2022). Developed countries with strict policies tend to impose stringent environmental protection policies (Assa et al., 2014).
As a result of this, companies tend to move away from developed economies that have restrictive environmental regulations to underdeveloped economies where they are relatively free to pollute the environment. In an investigation of the connection between global trade and environmental deterioration, Copeland and Taylor (1994) discover that while industrialized nations with free trade and strict environmental regulations improve their environmental quality, developing nations with lax environmental policies experience deterioration. Other researchers such as Wang et al. (2019) and Yasmeen et al. (2019) demonstrate that there is an inverted U-shape relationship between GVC participation and pollution. According to these researches, pollution rises during the early phases of GVC participation, but after a certain point, continued GVC growth causes pollution to decline. This is an indication that countries positioned at the beginning of the global value chains spectrum are likely to experience greater environmental challenges.
Chen et al. (2022) study the impact of global value chains embedding on carbon emissions included in Chinese exports for the period 2000-2014. The results show that both the forward embedding and backward embedding patterns are characterized by increased forward engagement, which is reflected in an increase in carbon emissions related to Chinese exports. The forward embedding pattern is defined by increasing the global value chain location index and stretching the forward production chain in order to help reduce the carbon emissions contained in exports. Duan et al. (2021) reassess the pollution haven effect on the global value chains of 40 major economies and find that the value added exports of less developed countries are extremely pollution-intensive. This validates the existence of the pollution haven effect in GVCs.
Solarin et al. (2017) examine the pollution haven hypothesis in Ghana for the period 1980-2012. The study analyzes time series data using autoregressive distributed lag (ARDL), and concludes that the pollution haven hypothesis exists in Ghana. Nguyen-Thanh et al. (2022) investigate the existence of the pollution halo hypothesis using panel data from 96 countries between 2004 and 2014. It is reported that investment inflows into developing countries have a greater polluting effect than in developed countries.
Abbasi et al. (2023) explore the pollution haven and pollution halo hypotheses in Asian countries over the period 1980-2020. The study confirms the validity of the pollution halo hypothesis, pollution haven hypothesis and EKC curve for selected Asian countries. Çağlayan-Akayn and Oskonbaeva (2022) conduct a non-linear panel ARDL analysis of pollution halo/haven hypothesis in 22 emerging countries from 1995 to 2016. The results indicate the presence of symmetric connections between the parameters, which implies that an increase in FDI results in better environmental quality, whereas, a negative shock is harmful to the environment.

The present paper fills a research gap in the body of academic literature. Researchers have worked on the relationship between international trade and environmental degradation; however, no study so far has dived deep into international trade from the perspective of forward integration into GVC. Furthermore, studies on Somalia's integration into global value chains are almost non-existent. This study therefore provides policymakers, especially in developing nations like Somalia, with useful insight into the environmental effects of participating in the relatively new global value chains.

3. Methodology and Data

3.1. Model Specification

The following model is proposed to empirically examine the environmental impact of Somalia's forward integration into global value chains:

L〖CO2PC〗_it= α_0+α_1 LDVX_it+α_2 LGDP_it+α_3 LURB_it+a_4 LRE_it+α_5 LTO_it+ε_it (1)

Where i and t are the cross-sectional and time dimensions. LCO2 is the logarithmic form of carbon dioxide emissions, LDVX is the logarithmic form of domestic value added of exports, LGDP is the logarithmic form of gross domestic product, LTO is the logarithmic form of trade openness, LURB is the logarithmic form of urbanization and LRE is the logarithmic form of renewable energy use. α_0 is the intercept of the model, while α_1 is the coefficient of study of the independent variables. α_1 to α_5 are coefficients of the regressors, and ε_it is the stochastic error term.

3.2. Data

To determine the environmental impact of Somalia's forward integration into global value chains, time-series data covering the period 1992-2018 for the variables included in eq. (1) is used for empirical analysis. The DVX index, which represents the domestic value added of Somalia, which is embedded in the exports of other countries, serves as the measure of forward integration into global value chains. The data on DVX is obtained from the UNCTAD-Eora Global Value Chain Database created by Casella et al. (2019) and may be accessed at https://worldmrio.com/unctadgvc.

Carbon dioxide (CO2) emission metric per ton is used as a proxy indicator for environmental pollution and it is obtained from the World Bank's Global Development Indicators database (https://databank.worldbank.org/source/globaldevelopment-indicators). In line with extant literature on the trade-environment nexus, the control variables—gross domestic product (GDP in US dollars), trade openness (trade % of GDP), renewable energy (% of total final energy consumption) and urban population (% of total population)—are also included in the empirical analysis. Data on the control variables are obtained from the World Development Indicators database of the World Bank (https://databank.worldbank.org/source/worlddevelopment- indicators).

3.3. Pre-estimation tests

In time series data investigations, unit root tests are often performed to establish the stationarity properties of the data series used for statistical analysis. This guards against the possibility of spurious regressions. Therefore, in this study, the augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) unit root tests are employed to prevent spurious results. The null hypothesis of both tests indicates the presence of a unit root, whereas the alternate hypothesis of the tests confirms its absence. Following the unit root tests, cointegration test is also conducted to establish the presence of a long-run relationship between the variables included in the empirical model. Specifically, the Johansen (1991) cointegration test is performed. The choice of this test is due to the fact that it provides the most precise values of cointegrating vectors and adjustment parameters (Pascalau et al., 2022).

3.4. Estimation technique

To determine the long-run environmental effect of Somalia's forward integration into global value chains, the dynamic ordinary least squares (DOLS) method developed by Stock and Watson (1993) is employed. DOLS has the ability to handle endogeneity problems which occur when regressors are correlated with stochastic terms in the regression model. By using this method, problems associated with serial correlation and small sample bias are also addressed through the inclusion of leads and lags (Kurozumi & Hayakawa, 2009). The method also produces reliable

results when the variables included in the empirical model are integrated of a mixed order, provided none of them is integrated of an order higher than one. The dynamic ordinary least square model is summarized below.

$$Y_t=\beta_0+\beta_1 X_t+\sum_{j=-m}^{n} [\![d\Delta X_{t-j}+\varepsilon_t]\!] \quad (2)$$

Where Y_t is the dependent variable, X is the vector of the explanatory variables, β represents the long-run coefficients of the cointegrating vector, n shows the lag lengths and m denotes leads.

4. Empirical Results

Table 1 presents the descriptive statistics of the variables mentioned in equation (1). Carbon dioxide Emissions ranges between 0.106 and 0.041 with a mean value of 0.060. Domestic value added of exports ranges between 29926.67 and 5850.72 with an average value of 12283.27. Gross domestic product has a maximum value of 5.86 billion dollars and minimum value of 83.25 million dollars. The mean value of Gross Domestic Product is 2.36 billion dollars. The study also indicates that the mean of renewable energy (92.882), trade openness (0.254), and urbanization (39515). Except for renewable consumption of energy, all other variables are positively skewed. The Jarque-Bera test statistics reveals that all variables are normally distributed. The plots in Figure 1 reveal that there has been a decline in the quantity of carbon emissions over the sample period in Somalia, while the graph of the main independent variable (LDVX) shows a steady rise in the domestic value of exports.

Table 1. Summary Statistics

	CO2PC	DVX	GDP	RE	TO	URB
Mean	0.060	12283.27	2.36 B	92.882	0.254	39515
Maximum	0.106	29926.67	5.86 B	94.930	1.065	69305
Minimum	0.041	5850.72	83.25 M	99.811	0.018	19515
Std.Dev	0.0165	4559.96	1.730	1.658	0.406	14977
Skewness	1.3618	2.149	0.951	-1.002	1.259	0.442
Kurtosis	4.053	9.455	2.595	3.236	2.691	2.031
Jarque-Bera (P-value)	9.5928***	67.672***	4.254	4.583	7.24***	1.936

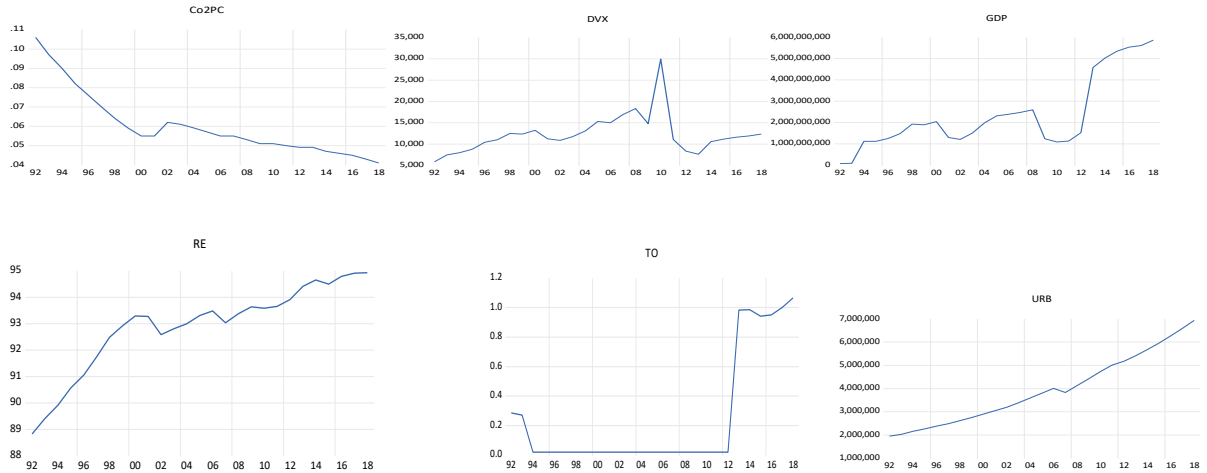

Figure 1. Plots of the variables

To determine the stationarity properties of the variables, the augmented Dickey-Fuller (1979) and the Phillips-Perron (1988) unit root tests are computed for each individual series. Table 2 reports both test outcomes. The ADF test results show that all the variables except LGDP are nonstationary at level; they however all become stationary at first difference. Hence, while LGDP is stationary I(0), LCO2PC, LDVX, LRE and LURB are I (1). The PP test results, on the hand indicate that all the variables are nonstationary at level and stationary after first differencing.

Table 2. Unit root test results

Variable	LCO2PC	LDVX	LGDP	LRE	LTO	LURB
ADF	-2.919	-2.866	-5.520***	-2.791	-2.275	-3.406
ΔADF	-3.732**	-6.355***	-4.770***	-3.591*	-5.408***	-5.450***
PP	-2.769	-2.824	-3.402	-2.678	-2.247	-3.409
ΔPP	-3.748**	-6.441***	-4.770***	-3.560*	-5.420***	-7.011***

Note: ***, ** and * denote statistical significance at 1%, 5% and 10% respectively for ADF & PP.

In Table 3, the trace statistics obtained from the Johansen cointegration test indicate that there are at least 4 cointegrating equations, confirming the existence of a long-run association between the variables in the model. Thus, domestic value added of exports, gross domestic product, renewable energy, trade openness and total population in cities have a long-run association with carbon dioxide emissions in Somalia. Since the presence of a long-run relationship amongst the variables is identified, the DOLS approach is suitable for empirical analysis.

Table 3. Cointegration Test Results

Unrestricted Cointegration Rank Test (Trace)				
Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.982773	286.1551	107.3466	0.0000
At most 1 *	0.957836	180.5617	79.34145	0.0000
At most 2 *	0.843195	98.24095	55.24578	0.0000
At most 3 *	0.751701	50.06944	35.01090	0.0007
At most 4	0.412808	13.84823	18.39771	0.1929
At most 5	0.000221	0.005752	3.841466	0.9388

Note: Trace test indicates 4 cointegrating eqn(s) at the 0.05 level.
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Finally, the DOLS regression is carried out to estimate the long-term effects of the forward integration into global value chains on the environment in Somalia. This technique is particularly preferred because it is able to produce robust results even when the variables are of mixed order of integration. The unit root results performed earlier provide conflicting results on the order of integration for GDP, making it difficult to clearly conclude whether the variable is I(1) or I(0). The DOLS results reported in Table 4 show that Somalia's forward integration into GVCs has a positive and significant long-run effect on CO2 emissions. A percentage increase in DVX results in 0.274% increase in CO2 emissions in Somalia. This leads to the conclusion that in Somalia, forward integration into global value chains raises pollution. This is perhaps an indication that Somalia is being assigned segments of the global value chains that require eco-unfriendly production processes, making the country a pollution sanctuary. It could also be an indication that raw materials that require dirty extraction processes are continually being sourced from Somalia. The outcomes of the control variables show that gross domestic product and urbanization have significant long-term effects on CO2 emissions in Somalia. A percentage increase in GDP and URB raises CO2 emissions by 0.087% and

1.165% respectively. This suggests that greater economic activity, as measured by GDP, harms the environment. Similarly, growth in urban population adversely affects the environment. This finding is supported by scholars such as Bieth (2021) and Onofrei et al. (2022). Trade openness likewise has a significant long-term positive effect on CO2 emissions in Somalia. An increase of 1% in trade openness leads to an increase of 0.036% in CO2 emissions. Renewable energy however significantly lowers carbon emissions in Somalia. A 1% increase in renewable energy use leads to a decrease of 14.65% in CO2 emissions. Studies with similar findings include Karedla et al. (2021), Szetela et al. (2022) and Chhabra et al. (2023).

Table 4. DOLS Results

Method: Dynamic Least Square (DOLS)

Dependent Variable: LCO2PC

Cointegrating equation deterministic: C@Trend

Variable	Coefficient	Std.Error	t-statistic	prob.
LDVX	0.274	0.084	3.258	0.031**
LGDP	0.087	0.033	2.606	0.060*
LRE	-14.652	1.479	-9.903	0.000***
LTO	0.036	0.010	3.594	0.023**
LURB	1.165	0.177	6.558	0.003***
C	42.585	4.852	8.776	0.000***
R-squared	0.999			

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

5. Conclusion and Recommendations

This study examines whether Somalia's forward integration into global value chains sets it up as a pollution haven, while controlling for the effects of gross domestic product, renewable energy, urban population and trade openness. Annual time-series data set for the period 1992-2018 is analyzed via dynamic least squares regression analysis. The study outcome reveals that forward integration into global value chains significantly aggravates environmental pollution in the country. his is in confirmation of the study hypothesis that Somalia may be serving as a pollution haven because of the relatively lax environmental policies that permit the inflow of pollution-intensive foreign direct investments, or due to the dominance of primary commodities in its exports which places it at the beginning of the GVC spectrum.

On the basis of the findings, a number of important policy recommendations are provided to help prevent Somalia from serving as a pollution haven. First, it is recommended that the government and policymakers strengthen environmental legislation to ensure that all companies, particularly those included in global value chains, conform to certain environmental standards. Second, it is recommended that policies be put in place to improve Somalia's production capacity. By being able to produce complex goods, Somalia will be able to move further along the GVC spectrum and no longer rely on the exports of primary products that require environmentally unfriendly extraction processes.

The third policy recommendation is the provision of financial incentives by the government to businesses that implement sustainable practices, such as grants or tax exemptions. This would motivate companies to spend money on more eco-friendly technologies, energy-saving techniques, and waste-reduction plans, ultimately lowering their environmental effect. The final recommendation is investment in capacity building programs by the government to improve the knowledge and abilities of regional industries in adopting cleaner production techniques. Furthermore, through allowing technology transfer from rich nations, developing nations can get access to more sophisticated and environmentally benign technologies, thereby lowering their reliance on harmful activities.

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