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Trade openness, poverty, and sustainable development: Testing for causality using Dumitrescu-Hurlin approach

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ABSTRACT

Purpose — *This research paper explores the causal links between trade openness, poverty, and sustainable development, shedding light on the potential impact of trade policies on poverty reduction and sustainable development in the Economic Community of West African States (ECOWAS) region.*

Method — *We utilize the Dumitrescu-Hurlin (DH) panel causality test, a robust econometric approach capable of discerning the direction and magnitude of causal relationships among variables. We employ a comprehensive dataset spanning from 1986 to 2020, covering ECOWAS countries, to conduct a rigorous empirical analysis.*

Result — *The empirical findings from the DH causality analysis reveal a unidirectional relationship between trade openness, human capital investment, and both sustainable development and poverty. Additionally, bidirectional causality relationships are observed between human capital investment and poverty. The results also highlight the absence of a consistent and uniform pattern of Granger causality between poverty and sustainability across individual West African economies. This heterogeneity underscores the need for customized policy approaches based on empirical evidence derived from country-specific causality analyses, rather than adopting one-size-fits-all solutions.*

Novelty — *This research stands out by exploring the causal connections among trade openness, poverty, and sustainable development within the Economic Community of West African States (ECOWAS) region. The adoption of the Dumitrescu-Hurlin (DH) panel causality test enhances the empirical analysis, offering a comprehensive understanding of both the direction and magnitude of these relationships.*

Keywords: *trade openness, poverty, sustainable development, ECOWAS, Dumitrescu-Hurlin (DH) approach*

INTRODUCTION

Trade openness has long been associated with economic growth and development. Proponents argue that an open trade regime fosters competitiveness, technological progress, and efficient resource allocation, thereby raising productivity and income levels (Chang et al., 2009). Theories of comparative advantage posit that trade enables countries to specialize in goods they can produce most efficiently, thereby maximizing global output and consumption gains from trade (Harrison & Rodríguez-Clare, 2010). It is also suggested that trade openness supports the transfer of knowledge and technologies across borders, enhancing productivity and growth. Recent studies utilizing instrumental variable techniques find causal impacts of trade on growth, though the magnitude remains debated (Feyrer, 2019). At the firm level, exposure to trade has been linked to innovation activities and technology upgrading as companies face increased competitive pressures. By incentivizing a more efficient allocation of resources and enabling technology diffusion, trade liberalization may allow developing countries to promote industrialization and structural transformation (Harrison & Rodríguez-Clare, 2010; McMillan et al., 2014). However, the impacts of trade openness on poverty and sustainability remain contested within both academic and policy spheres. Some studies suggest openness lifts people

out of poverty by creating jobs, lowering consumer prices, and diffusing growth (Goldberg, P. K., & Pavcnik, 2004). However, the poor are often unable to take advantage of new opportunities and are vulnerable to transitional adjustment costs (Ogede & Sina, 2014). Trade openness may disproportionately impact low-skilled workers concentrated in import-competing sectors, exacerbating inequality at least in the short run (Kovak, 2013).

On environmental measures, some studies find increased pollution from higher economic activity post-liberalization and composition effects shifting dirty production to developing countries (Manderson & Kneller, 2012). The uneven distributional impacts underscore the need for complementary policies to support poverty alleviation and sustainable development alongside trade openness (Chang et al., 2009). Empirical assessments accounting for country-specific conditions remains critical for informing this policy debate. Similarly, the environmental impacts of trade remain ambiguous. Openness may enable the spread of cleaner technologies or raise pollution levels with expanded economic activity (Frankel & Rose, 2005). Some studies find trade openness leads to a net increase in pollution as the scale effect dominates the technique effect (Shahbaz et al., 2015). However, the relationship varies based on the pollutant and country income levels (Omri & Kahouli, 2014). Hence, achieving sustainable development requires an empirical understanding of how trade openness interacts with poverty reduction and sustainability goals. Yet the causal mechanisms underlying these relationships are not well established. Most existing analyses rely on correlations from reduced-form models, making strong causal inferences difficult. Recent works utilize panel cointegration techniques and instrumental variables to better identify causality between trade, income, and emissions (Al-Mulali et al., 2015; Bekhet et al., 2017). But concerns remain about endogeneity bias and unobserved heterogeneity.

This paper contributes to the body of knowledge by applying a robust econometric advance to investigate the causal links between trade openness, poverty, and sustainability using the Dumitrescu-Hurlin (DH) panel Granger causality approach. The DH method accounts for unobserved heterogeneity and cross-sectional dependence to improve causal identification in panel settings (Dumitrescu & Hurlin, 2012). Using poverty metrics and sustainability indicators for a panel of ten (10) ECOWAS countries from 1987-2020, we examine the directional causal relationships between trade openness, poverty, and sustainability.

METHOD

The study is grounded in the augmented Solow model, as introduced by Mankiw et al. (1992), serving as an analytical framework for investigating the relationships among trade openness, poverty, and sustainable development. The model posits that labor and productivity experience constant growth rates, and the impact of trade activity on the economy is mediated through a level of technological advancement. Technical progress encompasses not only technology but also factors such as resource endowments, external sector resources, and climate change, all of which exhibit variation across countries. The per capita production function is specified as follows:

$$Y = K^{\alpha} (AL)^{1-\alpha} \qquad (1)$$

In the specified equation, *Y* represents output, *K* stands for capital, *L* for labor, and A for the level of technology. As per Mankiw et al. (1992), A is not solely indicative of technology but also encompasses resource endowments, the institutional framework, and climate change policy, all of which exhibit variation across countries. However, this study aims to scrutinize the causal connections among trade, poverty, and sustainable development, establishing a causal relationship to assess the significant impact of past values of x on the present value of y. Consequently, the Dumitrescu-Hurlin (DH) panel causality model is articulated as:

$$y_{i,t} = \alpha_i + \sum_{k=1}^{K} \gamma_{ik} y_{i,t-k} + \sum_{k=1}^{K} \beta_{ik} x_{i,t-k} + \varepsilon_{i,t} \qquad with\ i = 1, \dots, N\ and\ t = 1, \dots, T \tag{2}$$

In equation (2), $x_{i,t}$ and $y_{i,t}$ represent the observations of two stationary variables for individual *i* in period *t*. The coefficients are allowed to vary across the individual sample while remaining time-invariant, and the lag order K is assumed to be uniform across the panel. It is further assumed that the panel is balanced. The null hypothesis is stated as:

$$H_0: \beta_{i1} = \cdots = \beta_{ik} = 0 \qquad \forall_i = 1, \dots, \quad N$$

The model implies the absence of a specific direction of causality for all individuals in the panel. The DH test also assumes that there can be a causal link between some variables and not necessarily all. Therefore, the alternative hypothesis is formulated as:

$$H_1: \beta_{i1} = \cdots = \beta_{ik} = 0 \qquad \forall_i = 1, \dots, \quad N_1$$
$$\beta_{i1} \neq 0 \quad \text{or} \dots \text{or} \ \beta_{ik} \neq 0 \qquad \forall_i = N_1 + 1, \dots, N$$

Where $N_1 \in [0, N-1]$ is unknown. If N_1 is equal to 0 there is a causal link among the individual variables in the panel and N_1 must be strictly greater than N.

The study employs a quantitative methodology to explore the impact of poverty and trade openness on sustainable development in West Africa. The decision to focus solely on West African nations is influenced by both the emphasis on the region and the availability of reliable statistics on aggregated indicators of trade openness, poverty, and sustainable development in the Economic Community of West African States (ECOWAS). The selection of ten (10) countries is guided by the desire to limit attention to West African nations, and reliable data on aggregate indices of trade openness, poverty, and sustainable development in ECOWAS further informs this choice. The World Development Indicator (WDI) and the World Inequality Database, both published annually in 2021, provide the panel data used in the study. The study covers the period from 1987 to 2020, spanning 34 years.

Sustainable development is measured using adjusted net savings, following the computation approach of Cairns and Martinet (2014), among others, serving as a proxy for sustainable development. The prevailing capital stock is measured using gross fixed capital formation, drawing on the works of Abel and Eberly (2016), Holz (2006), van der Eng (2009), and Ogede & Tiamiyu (2022). Trade is measured with trade openness, following the methodology of Dithmer and Abdulai (2017). Poverty is measured using income below the poverty line, as in the works of Wang et al. (2022) and Maku et al. (2021). Inflation is measured with the consumer price index, following the methodology of Hodge (2006), and the exchange rate is measured with the nominal exchange rate.

Table 1. Description of variables

Abbreviation	Description	Measured as	Source
Y_{it}	Sustainable Development	Adjusted net savings, excluding particulate emission damage (% of GNI)	World Development Indicator (WDI), 2021
K	Domestic Capital	the ratio of gross fixed capital formation to GDP	World Development Indicator (WDI), 2021
T	Trade Openness	Ratio of trade to GDP	World Development Indicator (WDI), 2021
P	Poverty	Income below poverty line	World Inequality Database, 2021

CPI	Inflation	Consumer Price Index	World Development Indicator (WDI), 2021
EXR	Exchange Rate	Nominal Exchange rate	World Development Indicator (WDI), 2021

Source: Authors' compilation (2023)

RESULT AND DISCUSSION

Preliminary analysis

This section presents the preliminary analysis involving descriptive statistics and trend analysis of the variables under study for empirical analysis based on the formulated hypotheses. It includes descriptive and correlation analyses of trade openness, poverty, and sustainable development in the Economic Community of West African States (ECOWAS) countries.

The descriptive statistics and correlation matrix are provided in Table 2. The summary statistics in Table 2 indicate that the average genuine savings (y) stands at 1.39%, with the highest and lowest rates being 44.81% and -31.72%, respectively. This suggests that adjusted savings account for an average of 1.39% of sustainable development activities produced in the ECOWAS countries during the reviewed period. Regarding poverty (p), the mean value of the series is 0.126%, with maximum and minimum values of 0.16% and 0.035%, respectively. The mean value of the trade openness variable, measured by the ratio of total trade to GDP (t), is 54.97%, with maximum and minimum values of 131.48% and 16.9%, respectively. The average value of gross fixed capital formation (k) over the reviewed period is 18.79%, with a maximum value of 53.12% and a minimum value of -2.42%.

For the control variables, the mean values of the inflation rate (inf), measured by the annual growth rate of the consumer price index, and the official exchange rate (exc) are 76.32% and ₦587.20/US Dollar, respectively. The minimum values for these two control variables are -87.19% and ₦0.015/US Dollar, while the maximum values are 305.9% and ₦9010.22/US Dollar, respectively. Table 2 also presents the partial correlation of trade openness, poverty, sustainable development, human capital investment, inflation, and exchange rate in ECOWAS countries using an annual dataset within the period of 1987 and 2020. The correlation results show that the indicator of sustainable development, proxied with adjusted net savings, has a positive level of association with human capital investment, poverty, and inflation. The correlation matrix also reveals that sustainable development is negatively associated with trade openness and exchange rate. Furthermore, the correlation table indicates that poverty positively correlates with human capital investment, inflation, and exchange rate, but negatively relates to trade openness. Additionally, the correlation coefficient of trade openness shows a positive level of association with human capital, exchange rate, and inflation.

Table 2. Summary statistics and correlation matrix

Variable measurements	Mean	Max.	Min.	S.Dev.	Skew.	Kurt.	Obs.
Outcome variables							
Genuine savings (y)	1.3953	44.816	-31.727	12.600	0.2922	3.4391	338
Poverty (p)	0.1267	0.169	0.0352	0.0226	-1.2373	5.4314	338
Trade (t)	54.975	131.49	16.940	18.174	1.1916	4.9462	338
Main explanatory and control							
Gross fixed capital format.(k)	18.798	53.122	-2.4243	8.7327	1.1317	5.2025	338
Inflation (inf)	76.327	305.98	-87.192	52.392	0.5939	5.9288	338
Exchange rate (exc)	587.20	9010.2	0.0154	1056.71	4.8521	30.447	338

Correlation matrix

	Y	**P**	**t**	**K**	**inf**	**exc**
Genuine savings (y)	1					
Poverty (p)	0.233	1				

Trade (*t*)	-0.142	-0.076	1			
Gross fixed capital formation (*k*)	0.592	0.144	0.063	1		
Inflation (*inf*)	0.078	0.511	0.040	0.000	1	
Exchange rate (*exc*)	-0.242	0.232	0.064	-0.118	0.251	1

Note: S.Dev. – standard deviation; Max. – maximum; Min. – minimum; Skew. – Skewness; Kurt. – Kurtosis; Obs. - observation.

Source: Authors' computation (2023)

Analysis of the direction of causality among trade openness, poverty, and sustainable development within the ECOWAS countries

In this sub-section, the study presents the empirical outcomes regarding the direction of causality among trade openness, poverty, and sustainable development within the ECOWAS countries. The results of the Dumitrescu-Hurlin (DH) causality test reported in Table 3 reveal the direction of causalities among trade openness, poverty, sustainable development, human capital investment, and other control variables.

The causality results in Table 3 uncover the existence of a unidirectional causality between poverty and sustainable development, human capital investment and sustainable development, and sustainable development and trade openness. Additionally, these causality results expose bidirectional causality relationships concerning human capital investment and poverty. The findings of the DH causality, as reported in Table 3, further underscore the significance of developing sound sustainable development policies in the selected ECOWAS countries. The identified causal relationships provide insights into the dynamics among trade openness, poverty, and sustainable development, highlighting areas where policy interventions may be particularly impactful.

Table 3. Results of Dumitrescu Hurlin (DH) panel causality tests

Null hypothesis	W-Stat.	Zbar-Stat.	Prob.	Direction of causality
*ln*pov ≠> *ln*AdjSav	**3.67747	2.04822	0.0405	
*ln*AdjSav ≠> *ln*pov	3.29352	1.52975	0.1261	Unidirectional
*ln*K ≠> *ln*AdjSav	** 3.77688	2.18246	0.0291	
*ln*AdjSav ≠> *ln*K	3.31453	1.55813	0.1192	Unidirectional
*ln*T ≠> *ln*AdjSav	3.04385	1.19093	0.2337	
*ln*AdjSav ≠>*ln*T	** 3.63157	1.98406	0.0472	Unidirectional
*ln*inf ≠>*ln*AdjSav	3.33075	1.58003	0.1141	
*ln*AdjSav ≠> *ln*inf	2.15354	-0.00962	0.9923	Neutrality
*ln*exc ≠> *ln*AdjSav	3.25903	1.48318	0.138	
*ln*AdjSav ≠>*ln*exc	2.62336	0.62480	0.5321	Neutrality
*ln*K ≠>*ln*pov	***4.51294	3.17935	0.0015	
*ln*pov ≠>*ln*K	** 3.86399	2.30248	0.0213	Bi-directional

Notes:
1. Asterisk(s) ***, **, * represent(s) the rejection of the null hypothesis at 1%, 5% and 10% significance levels.
2. The symbol ≠> implies does not homogeneously cause.

Source: Authors' computation (2023)

Examining the individual regressions, our analysis affirms the poverty-sustainable development hypothesis only for Gambia and Senegal (refer to Table 4). While the sustainable development-poverty hypothesis has been validated for Benin and Niger, there is no consistent causal relationship between poverty and sustainable development in the panel. This panel spans the years 1987 to 2020 and encompasses Benin, Ghana, Guinea-Bissau, Mali, Niger, Nigeria, Sierra Leone, and Togo. This observation implies that sustainable development does not Granger cause

poverty in at least one country within the panel. The varying causal relationships across individual countries underscore the nuanced nature of the poverty-sustainable development dynamics within the ECOWAS region.

Table 4. Results for Dumitrescu-Hurlin (DH) causality test in each country

Null Hypothesis: Pov ≠> AdjSav AdjSav ≠> pov	**Causality Path**	
	Z-Bar Tilde Statistic	
Country	**Pov**	**AdjSav**
Benin	1.269 (0.537)	7.035 (0.044)**
Ghana	2.403 (0.316)	1.559 (0.468)
Gambia	7.045 (0.043)**	4.586 (0.12)
Guinea-Bissau	3.044 (0.236)	4.315 (0.135)
Mali	4.668 (0.116)	1.589 (0.462)
Niger	3.272 (0.213)	10.143 (0.013)**
Nigeria	1.917 (0.396)	2.037 (0.375)
Sierra Leone	3.26 (0.214)	0.993 (0.614)
Senegal	5.84 (0.071)*	1.127 (0.576)
Togo	3.904 (0.162	0.319 (0.853)

Notes: Asterisk(s) ***, **, * represent(s) the rejection of the null hypothesis at 1%, 5% and 10% significance levels.
The symbol ≠> implies does not Granger cause for at least one panel country. While figures in parentheses are *p*-values.

Source: Authors' computation (2023)

Additionally, Table 5 shows that there is no causal link between trade openness and sustainable development in the panel, which spans the years 1987 to 2020 and includes Benin, Gambia, Guinea-Bissau, Mali, Niger, Nigeria, Sierra Leone, and Togo. However, the panel found no evidence of a causal link between trade openness and sustainable development. Between 1987 and 2020, these nations include Benin, Ghana, Guinea-Bissau, Mali, Niger, Nigeria, Senegal, and Togo. The results point to the existence of the trade openness-sustainable development hypothesis for Sierra Leone and Benin.

Table 5. Results for Dumitrescu-Hurlin (DH) causality test in each country

Null Hypothesis: AdjSav **≠> t** **t ≠>** AdjSav	**Causality Path**	
	Z-Bar Tilde Statistic	
Country	**AdjSav**	**T**
Benin	3.764 (0.172)	0.421 (0.812)
Ghana	5.864 (0.07)*	1.611 (0.457)
Gambia	0.258 (0.879)	11.631 (0.007)***
Guinea-Bissau	1.314 (0.526)	1.771 (0.424)
Mali	0.268 (0.875)	0.577 (0.751)
Niger	6.181 (0.062)	4.247 (0.139)
Nigeria	2.906 (0.252)	1.173 (0.563)
Sierra Leone	0.721 (0.701)	10.458 (0.012)**
Senegal	6.598 (0.052)*	2.855 (0.257)
Togo	2.752 (0.269)	2.365 (0.322)

Notes: Asterisk(s) ***, **, * represent(s) the rejection of the null hypothesis at 1%, 5% and 10% significance levels.

Source: Authors' computation (2023)

Discussion on findings

The objective of this study is to explore the direction of causality among trade openness, poverty, and sustainable development within the ECOWAS member states. The Dumitrescu-Hurlin (DH) causality test results unveil the causal relationships among key variables related to development in West African countries, covering the period from 1987 to 2020. Specifically, a statistically significant unidirectional causation is observed from poverty to sustainable development (at the 1% level). This implies that poverty reduction is a Granger cause of higher sustainability, encompassing panel data from Benin, Gambia, Guinea-Bissau, and several other nations. However, no reverse causality is identified from sustainable development to poverty in this collective analysis. This one-way causation emphasizes the importance of focusing on poverty reduction for the enhancement of sustainability.

Secondly, the DH test indicates another unidirectional causal link, this time running distinctly from sustainable development to trade openness in the panel data. Continuous periods of sustainable growth prompt higher trade openness for West African countries. Nevertheless, no causation is found in the opposite direction, emphasizing sustainable development as a precursor for trade openness. This contradicts claims made by Abubakar et al., (2015) regarding the correlation between trade openness and sustainable growth in Saudi Arabia in both directions.

In contrast to the two unidirectional causations mentioned above, the DH test reveals a bi-directional causal relationship between human capital investments (education, health, skills, etc.) and poverty levels. Enhanced human capital is identified as a Granger cause of poverty reduction, while lower poverty levels lead to increased capacity for human capital investments subsequently. This two-way linkage underscores the cyclical dependence and mutually reinforcing association between improved human capital and poverty alleviation in the studied countries over three decades.

These multivariate findings outline the policy priorities for the region: poverty alleviation Granger causes sustainability, which, in turn, facilitates trade openness. Simultaneously, human capital building interdependently influences poverty. Consequently, welfare schemes addressing poverty and human capital assume primacy within the causality framework for West Africa, rather than isolated trade reforms.

Furthermore, an examination of the causal linkages between poverty and sustainability at the individual country level reveals variations from the aggregated panel data results. Specifically, for The Gambia and Senegal, country-specific DH causality tests confirm the poverty-sustainable development hypothesis over the 1987-2020 period. A one-way causation is identified, flowing from decreasing poverty to higher sustainability for both nations, emphasizing the significance of poverty alleviation for sustainable growth in these countries. In contrast, for Benin and Niger, country-specific DH tests show causality running distinctly from higher sustainability to reduced poverty levels. This aligns more closely with the sustainable development-poverty hypothesis for these two countries within the panel. Therefore, sustainability-stimulating interventions such as green investments, clean infrastructure projects, and eco-friendly agricultural initiatives can effectively combat poverty in Benin and Niger based on the findings.

CONCLUSION

This study investigates the interrelationship among trade openness, poverty, and sustainable development in ECOWAS using annual data from 1987 to 2020. The estimator employed is the Dumitrescu-Hurlin (DH) approach. The empirical results of the DH causality analysis show a one-way relationship between trade openness, human capital investment, sustainable development, and poverty. Bidirectional causality relationships are also observed for human capital investment and poverty. The findings emphasize the significance of developing sound sustainable development policies in the selected ECOWAS countries.

The study concludes that the observed relationship among trade openness, poverty, and sustainable development in ECOWAS countries is consistent with the empirical results obtained from previous studies. In view of these findings, the policy implications and recommendations are presented in the ensuing discussion. Firstly, the observed unidirectional causality from poverty reduction to sustainable development implies that policies aimed at alleviating poverty can improve sustainable development outcomes in the long run. Governments of ECOWAS nations should prioritize programs targeting poverty reduction, such as conditional cash transfers, expanding employment opportunities, and improving access to healthcare and education. Secondly, the unidirectional causality from human capital investment to sustainable development highlights the critical role of investing in education, health, and skills development for achieving sustainability goals. Policymakers in the selected ECOWAS countries should increase budgets and improve the effectiveness of public expenditure on health, education, vocational training, and other human capital investments.

Further, variations at the individual country level prompt diverse recommendations for policy formulation. The results advocate for targeted anti-poverty programs in Gambia and Senegal, emphasizing the pursuit of sustainability dividends over conventional growth maximization schemes. In these nations, the observed one-way causation from decreasing poverty to higher sustainability underscores the strategic importance of poverty alleviation as a key driver for sustainable development. Conversely, for Benin and Niger, where the causal relationship points from higher sustainability to reduced poverty levels, a different approach is warranted. Policies should prioritize sustainability-stimulating interventions, such as green investments, clean infrastructure projects, and eco-friendly agricultural initiatives, as effective strategies to combat poverty. The emphasis shifts from direct anti-poverty initiatives to those fostering sustainable development, acknowledging the unique dynamics of these countries. The need for tailored policy approaches becomes evident considering these country-specific differences. A one-size-fits-all strategy is insufficient to address the nuanced challenges and opportunities presented by the divergent causal relationships. Policymakers should recognize the distinct patterns uncovered by the causality analyses and design interventions that align with the specific dynamics of each country.

While the study examines causality at the ECOWAS regional level, subsequent empirical literature endeavors could delve deeper into country-specific discussions to enhance the body of knowledge on how individual nations contribute to overarching regional trends. Additionally, an exploration into the role of institutional factors, encompassing governance structures, legal frameworks, and policy implementation, could elucidate how these elements mediate the observed relationships, contributing to a more comprehensive understanding of the mechanisms propelling sustainable development. Future studies might also probe the impact of significant global events, such as economic recessions, pandemics, or geopolitical shifts, on the identified relationships. Understanding how external shocks influence the interplay between trade openness, poverty, and sustainable development can provide valuable insights for policymakers.

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