Productive Capacities and the SDGs: Critical But Nuanced Relationships

David Tennant
University of the West Indies, Jamaica
david.tennant@uwimona.edu.jm

Sandria N. Tennant
University of the West Indies, Jamaica
sandria.tennant@uwimona.edu.jm

Stuart Davies
United Nations Resident Coordinators Office, Jamaica
stuart.davies@un.org

Patrice Whitely
University of the West Indies, Jamaica
patrice.whitely02@uwimona.edu.jm

It is widely accepted that productive capacities are an enabler for the UN sustainable development goals (SDGs), but there is a dearth of literature empirically testing this view. This paper examines the relationships between productive capacities and the SDGs and reveals nuances that need to be accounted for in integrated development approaches. Using panel data time series models, with Driscoll-Kraay adjusted standard errors, we examine how enhancing the eight elements of the Productive Capacity Index (PCI) impacts the SDGs. We find that each of the SDGs has statistically significant relationships with multiple elements of the PCI, and the results highlight areas in which productive capacity enhancements accelerate progress on one or more SDGs but can also be inimical to others, particularly to goals related to the environment and income inequality. Our approach provides development practitioners with a new framework to better target SDG interventions.

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Introduction

More frequent global economic crises and heightened climate risks have led vulnerable economies, such as the Least Developed Countries (LDCs) and Small Island Developing States (SIDS), to prioritize economic resilience in their development planning processes. Greater resilience, defined as the ability of an economy to mitigate, adapt to, and recover from shocks, is derived, inter alia, through a robust and more diversified fabric of productive capacities (UNCTAD 2006a; Briguglio et al. 2009). Such capacities include the 'productive resources, entrepreneurial capabilities and production linkages that together determine a country's ability to produce goods and services' (UNCTAD 2021a, p. 8).

Although enhancing countries' productive capacities is important to achieving the UN Sustainable Development Goals (SDGs), this simplistic view does not serve policymakers in resource-constrained economies well. This is because both the SDGs and a country's productive capacities are multifaceted and multidimensional concepts, with complex, nuanced interrelationships. The achievement of some sustainable development goals can impede progress in others, and the enhancement of some productive capacities can adversely affect achievement of some of the SDGs (Morton, Pencheon, and Squires 2017; Lawrence, Ihebuzor, and Lawrence 2020a). A regularly used example highlights the tension between the SDGs related to socio-economic development and those focused on environmental degradation, which could be exacerbated through the enhancement of productive capacities such as energy, natural capital and certain types of structural transformation.

A high degree of interconnectedness among and between the SDGs and a country's productive capacities complicates the process for achieving the SDGs. An approach that seeks to maximize synergies and mutually reinforcing objectives, while minimizing conflicting and perverse outcomes is needed (Griggs et al. 2014). Systems approaches to analyse and plan for the SDGs, which can manage these complexities, uncertainties, and interconnectedness of economic and socioeconomic issues, are therefore called for (Sachs et al. 2019; Freeman et al. 2014).

Systems approaches are particularly important when one considers how efforts that enhance each of the eight productive capacities[1] which make up the United Nations Conference on Trade and Development (UNCTAD) Productive Capacities Index impact each of the seventeen SDGs. While some efforts may be mutually reinforcing, positively and directly impacting multiple SDGs, others may have conflicting impacts on different goals, and through their impact on one SDG, have spill-over, indirect effects (whether positive or negative) on other SDGs. The systems approach to the SDGs that has been advocated seeks to analyse the various components, interactions, and dynamics in an integrated manner that targets the realization of the desired outcomes (Lawrence, Ihebuzor, and Lawrence 2020b).

This paper utilizes a systems approach to explore the nuances of the relationships between the different aspects of productive capacity and each of the SDGs. UNCTAD's categorization and measurement of productive capacities is used to determine countries' capacities in human capital, natural capital, energy, transport, information and communications technology (ICT), institutions, the private sector, and structural change. Countries' performances in each of these are regressed first against countries' overall SDG scores, and then against each of the individual SDGs, to ascertain what the nuanced relationships are between the multifaceted components of sustainable development and productive capacity.

In so doing, the paper adds to the literature by assessing the impact of economic complexity and structural transformation on sustainable development. The UNCTAD (2021a) report asserts that enhanced productive capacities enable countries to be more resilient and better able to respond to shocks, such as the COVID-19 pandemic and other natural hazards. Examining the relationships between productive capacities and the SDGs are critical to that discourse, as it is only through enhanced productive capacities that countries can structurally transform and achieve greater economic complexity. This paper therefore strikes at the root of the issue, with sustainable development and economic resilience being the end goals.

The next section of this paper summarizes the extant literature on the relationship between productive capacity and sustainable development, highlighting the complexities and need for further research. This is followed by a description of the methodology and data used as well as the regression results, sensitivity analysis, and conclusions derived.

Sustainable Development and Productive Capacity: A Brief Summary of the Literature

Sustainable development has been defined as 'the process of improving the quality of human life while living within the carrying capacity of supporting ecosystems' (Ozili 2022, p. 262). Productive capacities have been broadly defined by UNCTAD (2006b, p. 61) as focusing on 'both structural and supply-side constraints, and encompassing physical infrastructure, technology, enterprise development and energy, as well as specific sectoral challenges in relation to agriculture and agro-industries, manufacturing and mining, rural development and food security, and sustainable tourism'. Sustainable development in any country is dependent on its productive base. This is well established in economic theory. In classical development theories, such as by Prebisch (1950), and Lewis (1954), development was predicated on the need for high capital accumulation and the transformation of the productive structure (Andreoni and Chang 2017).

Although neoclassical economics de-emphasized production in favour of exchange, the underlying importance of productive capacities is fundamental to the well-used Cobb-Douglas production function. In the simplest form of the Solow growth model, aggregate output is determined by labour, capital, and technology, with diminishing returns to labour and capital separately and constant returns to both factors jointly. Improvement in an economy's long-term rate of growth is thus dependent on productivity improvements, which the model assumes are caused by technological change (Todaro 2000). Endogenous growth theorists explained such technological change by broadening the definition of capital to include, inter alia, human capital, and intangible capital such as knowledge. Achieving enhanced innovation through learning by doing and research and development was thus shown to be critical to long-term economic growth (Becsi and Wang 1997).

Aschauer (1989) also improved on the simple Cobb-Douglas production function framework by adding public capital to private capital, labour and technology as explanatory variables for output. He found the output elasticity of infrastructure to have a high and significant impact on output and growth, and argued that core infrastructure, which consists of highways, mass transit, airports, electrical and gas facilities, water, and sewers contributes highly to productivity growth.

New institutional economics further theorized that economic success is achieved with the formulation of institutional innovations that lower the costs of transactions, permit the capturing of more gains from trade, and foster the expansion of markets (North 1990, p. 3). Theoretical justification for the critical elements of productive capacity included in our model (human capital, natural capital, infrastructure – including transport, ICT and energy, and institutions and the private sector) is thus provided in the foundational classical and neoclassical theories of growth and development.

Several empirical studies have examined countries' productive capacities, with results indicating that cross-country differences in resource endowment and productive capacity lead to uneven levels of sustainable development (Dasgupta, Managi, and Kumar 2022; Ozili 2022). Xin et al. (2023, p. 2) note that 'a country's productive capacity is interconnected with basic factors that allow equitable and sustainable growth and development'. There is consensus in the literature that inadequate productive capacities limit countries' economic outputs, leaving them reliant on a narrow range of exports (Isaksson 2007). This has been the fate of many LDCs, precipitating advocacy for clear policy guidance for fostering economy-wide productive capacity in such countries (Castell 2021). The challenge, however, is that while many of the theoretical and empirical studies have focused on one or a few productive capacities, far fewer attempt to holistically measure and examine countries' productive capacities generally and assess the impact of such capacities on achieving sustainable development.[2]

Andreoni and Chang (2017) suggest that this may be due to the proclivity of neoclassical theory to ignore the dynamics of production by underestimating the heterogeneity of production activities within and across production sectors and neglecting the critical role of productive transformation. They introduce a theoretical framework in which development is reconceptualized as a process of production transformations, led by the expansion of collective capacities that results in the creation of good employment and sustainable structural change.

Andreoni and Scazzieri (2014) developed a theoretical model in which they similarly emphasized the importance of production arrangements and the dynamics of production structures. Their model utilized the classical laws of increasing and decreasing returns and adopted a dual representation of production structures. They showed that different increasing and/or decreasing returns trajectories may be identified depending on which production units and levels of aggregation are under consideration. They show that any given economic system may follow a plurality of structural trajectories and conclude that analysis of the relationships between production structure and economic dynamics can help to identify triggers of change and how they work, to design targeted measures for setting economic systems on different transformation paths. It was therefore important to include structural transformation in our model to test its potential impact on sustainable development.

This is in line with the approach adopted by UNCTAD (2006b), who by citing the eclectic contributions of early development economists such as Lewis (1954), Kalecki (1969), and Kaldor (1967, 1981), assert that the dynamics of production structure matters for economic growth, with structural transformation, productivity growth and international competitiveness being driven by the processes of technological learning, along with capital accumulation. In the context of the SDGs, UNCTAD (2020) noted that the underlying factors driving performances in the SDGs were not being adequately analysed. UNCTAD thus developed the Productive Capacities Index (PCI) as a policy tool to aid in measuring national performance in productive capacities and their potential to reach the targets under the SDGs.[3] The PCI is designed to be used to identify and evaluate the strengths and weaknesses of a country's productive capacities and to inform policy for the effective building of such capacities for sustained growth.

The PCI is a relatively new measure, and has sparked renewed empirical interest in testing the relationship between productive capacities and sustainable development. The results of several regression analyses show that productive capacities can play a crucial role in meeting the SDGs. Specifically, countries with higher levels of productive capacities have been shown to perform better in SDGs 1 to 4, 8, 9, and 11. UNCTAD (2021b) thus emphasizes the importance of productive capacities in enabling structural transformation, which can lead to poverty reduction and help make inroads in bringing about food security, education, and urbanization-related indicators under the Global Goals.

As to the effect of the PCI on environmental degradation, Oluc et al. (2023) examined the relationship between carbon dioxide emissions, economic growth, and the PCI for a panel of 38 Organisation of Economic Cooperation and Development (OECD) countries between 2000 and 2018. They found that increasing productive capacity can play an important role in reducing CO_2 emissions. Xin et al. (2023, p. 2) note that 'successive waves of technical development boost productivity and lead to reduced resource use and emissions'.

It is, however, important to acknowledge that sustainable development and productive capacities are both multi-dimensional concepts, involving interactions between economic, social, environmental and governance dimensions. A simplistic view of the relationship between them can lead to important nuances being overlooked. The Sustainable Development Goals (SDGs) adopted by the United Nations in 2015 incorporate 17 goals, 169 targets and 231 indicators (Cling and Delecourt 2022; Breuer et al. 2023). The existence of trade-offs, synergies and co-benefits between these goals and targets have been highlighted by many authors (e.g. Cling and Delecourt 2022; Bali Swain and Yang-Wallentin 2020). Although some studies have confirmed positive, mutually reinforcing relationships between most of the goals, others find inherent conflicts between some goals, particularly those relating to socio-economic development and environmental sustainability (Dawes, Zhou, and Moinuddin 2022; Lawrence, Ihebuzor, and Lawrence 2020a). Ravallion (2020), for example, noted that achievement of SDG-1 (Zero Poverty) post-COVID-19 will almost certainly require economic growth in poor countries, which will come with environmental costs, including global warming. Empirically, studies such as those by Sharmin and Tareque (2018, 2020), Linh and Lin (2014), Griggs et al. (2014), Delabre, Alexander, and Rodrigues (2020), and Nilsson, Griggs, and Visbeck (2016) highlighted examples of how approaches to economic development can negatively impact the environment.[4]

Many of the studies that have sought to shed light on the interrelationship between socio-economic development and environmental sustainability have tested the Environmental Kuznets Curve (EKC) theory. This theory suggests an inverted U-shaped relationship between environmental degradation and economic growth (Linh and Lin 2014). 'At early stages of development, it is hypothesized that the environment deteriorates with economic growth, until a certain level of per capita income is reached, beyond which further increases in income result in environmental improvements' (Panayotou, Peterson, and Sachs 2000, p. 5). Leal and Marques (2022), however, reviewed more than 200 articles from 1998 to 2022 on the EKC and did not find any consensus in the literature on the existence of the EKC. Panayotou, Peterson, and Sachs (2000, p. 15) concluded that 'further research is needed to untangle the diverse and shifting forces underlying the environment-growth relationship'.

A similar type of conflict has been observed between economic growth and the SDGs' social sustainability targets, particularly SDG-10 (reduced inequalities). Empirical evidence in some regions has been found supporting Kuznets' (1955) theorized inverse U-shaped pattern of inequality, wherein as countries developed, income inequality first increased, peaked, then decreased. In other regions, notably East Asian countries, including South Korea, Japan and Taiwan, monotonically falling inequality was experienced (Acemoglu and Robinson 2002). Andreoni and Chang (2017) assert that understanding the importance of structural transformation and productive capacities helps to explain the divergence of experiences. They also note that social sustainability requires an increase in the number and quality of jobs and not simply the satisfaction of basic needs, which is dependent on economic growth that is driven by production transformation.

The lack of clarity on, and likely conflicting relationship between the three pillars of sustainable development 'makes it challenging to determine the most effective strategy to create sustainable development' (Bali Swain and Yang-Wallentin 2020, p. 105). Bervar and Trnavčevič (2019, p. 196) contend that 'in practice, sustainable development means searching for, debating and seeking compromise among different concepts'. Sachs et al. (2019) suggest systems-based approaches to deal with trade-offs between SDG interventions and have sought to provide guidelines on how to organize the implementation of these interventions in a manner designed to maximize impact and minimize trade-offs. Such systems-based approaches are critical, as 'increased policy coherence and integrated implementation are necessary to address pressing development problems that cut across different sectors' (Breuer et al. 2023, p. 1). This necessitates nuanced analyses and rigorous research to guide policymakers as they seek to establish codes, standards, and legislation to allocate resources in pursuit of sustainable development (Ozili 2022; Bervar and Trnavčevič 2019).

This is particularly so as countries seek to achieve the SDGs through enhancement of their productive capacities. Like the SDGs, countries' productive capacities have multiple components that are interconnected, reinforcing, and sometimes conflicting, giving rise to a need for nuanced development interventions. Strong policy guidance is needed if developing countries are to target the SDGs effectively through enhanced productive capacities. However, very little such guidance currently exists and the guidelines provided by Sachs et al. (2019) on implementing SDG interventions do not consider developing countries' need to simultaneously enhance their productive capacities or assess empirically the measures proposed. A holistic approach, which considers the complex relationships and interrelated character of the SDGs and productive capacities is required. Furthermore, as very few developing country governments will have access to the financial and human resources to tackle all of the required policy initiatives at once, a phased and properly sequenced approach built on a thorough and nuanced understanding of the relationship between the SDGs and productive capacities will be crucial. It is this gap in the literature that this paper seeks to fill.

Methodology

This paper estimates the relationship between a country's performance on the SDGS and its productive capacities, utilizing a panel time series model. Both fixed effects and random effects models were initially estimated, and a Hausman Test for fixed or random effects was conducted. Test P-values confirmed that the fixed effect model was the appropriate model to use. The estimation pools together the models for all countries into a single regression model by adding country-specific dummy variables γ1, γ2, ..., γn corresponding to the *n* countries included in the dataset.

The following model is therefore estimated:

$$\begin{aligned} SDG\ Score_{i,t} = \alpha_0 + \beta_1 PCI\ components_{i,t-1} \\ + \beta_2 [PCI\ components_{i,t-1}]^2 \\ + \beta_3 controls_{i,t-1} + \beta_4 Trend_i + \gamma_i + \delta_t + u_{i,t} \end{aligned} \quad (1)$$

where the SDG Score represents each country's SDG score measured annually, and PCI components denotes individual variables for human capital, natural capital, energy, transport, information and communications technology, institutions, the private sector, and structural change. A set of control variables are also included as well as a constant term, time trend, time effects dummies and individual country fixed effects.

The fixed effects model shown by equation (1) therefore involves estimating the coefficients for each of the independent variables, time trend, time effects and the country-specific effects for country (i). $SDG\ Score_{i,t}$ is a scalar containing the sustainable development goal score of country i, at time t; the main independent variables of interest are listed above; $controls_{i,t-1}$ is a row vector of size $[1 \times k]$ containing the values of k control variables, for country i at time t-1; β_3 is a column vector of $[k \times 1]$ containing the regression coefficients for the k control variables; and $u_{i,\ t-1}$ is a scalar containing the error term of the regression for country, i at time $t-1$.

Before estimating (1), several pre-regression diagnostic tests were conducted. The errors were tested for heteroscedasticity and autocorrelation using the Breusch-Pagan test and the Wooldridge test for autocorrelation in panel data, respectively. Both heteroscedasticity and autocorrelation were found to be present, suggesting that the standard errors of the regression model must be appropriately adjusted. The results for the

Hausman, Breusch-Pagan, and Wooldridge tests are presented with the regression results in table 3.

When using panel data, the possibility of cross-sectional or spatial dependence is also a cause for concern. In the presence of cross-sectional dependence, if the unobserved common cross-country factors are independent of the explanatory variables, the fixed effects estimator will still be consistent, but it will be inefficient. Therefore, both the Pesaran and the Frees test for cross-sectional dependence were conducted. These tests were selected because they can handle both balanced and unbalanced panels and are suitable for a finite T. The results for the Frees tests are also reported in table 3.[5] The values in the table indicate that the null hypothesis of cross-sectional independence is rejected at all conventional significance levels. To correct for this, we ran the regression analysis using the Driscoll-Kraay standard errors. As highlighted in Hoechle (2007), in the presence of cross-sectional dependence, the Driscoll-Kraay standard errors are more robust than the Newey-West standard errors. Hoechle (2007) also uses simulations to show that, even though the Driscoll-Kraay standard errors are intended for panels with a large time dimension, they still perform well even when T is as low as 5.

The presence of cross-sectional dependence in the model implies that when testing for stationarity, second-generation unit root tests should be used. However, as noted in Blackburne and Frank (2007), issues such as slope heterogeneity and non-stationarity are typically a cause for concern when T is large. Despite our T being relatively small, unit root tests were conducted. The second-generation Pesaran test was attempted. However, results could only be obtained for the SDG score due to gaps in the data for the other variables. The Dickey-Fuller version of the Fisher test was conducted on all the variables since it allows for unbalanced panels. For all the variables, the null hypothesis that all panels contain unit roots was rejected at the 1% level.[6] The result of the Pesaran test on SDG score was consistent with the result of the Fisher test.

Even though neither the Dickey-Fuller version of the Fisher test nor the Pesaran test gave us reason to be concerned that the SDG variable may be unstable, because the SDG goals were established in 2015 and the values of the SDG index before that year were extrapolated, we conducted further tests to ascertain whether there was a structural break in the data at or near 2015. The panel data unit root test presented in Karavias and Tzavalis (2014) was conducted, as it allows for the existence of one or two structural breaks in the time series. The results did not indicate a structural break at or near 2015, and rejected the null hypothesis that all the time series are unit root processes. This suggests that there was no change in the distribution of the variable over the review period. The results for the Fisher unit root tests are presented in tables 1 and 2.[7, 8]

Data

The data utilized in this study are compiled from the World Bank, International Monetary Fund, and the United Nations – United Nations Sustainable Development Solutions Network (UNSDSN) and UNCTAD.

TABLE 1 Descriptive Summary Statistics for the Dependent Variables

Variables	Description	Obs.	Mean	Median	Std. dev.	Min	Max	Fisher P-value
SDG Overall	Overall	3,749	64.1	65.2	10.5	38.4	86.5	0.000
SDG 1	No Poverty	3,738	71.8	88.2	32.4	0	100	0.000
SDG 2	No Hunger	3,749	57.9	59.0	11.2	11.5	83.6	0.000
SDG 3	Good Health and Well-Being	3,749	64.5	71.3	22.5	11.5	97.2	0.000
SDG 4	Quality Education	3,748	70.9	79.6	27.2	0.0	99.9	0.000
SDG 5	Gender Equality	3,749	55.6	57.6	17.8	3.4	91.9	0.000
SDG 6	Clean Water and Sanitation	3,749	65.4	66.5	15.5	23.3	95.1	0.000
SDG 7	Affordable and Clean Energy	3,749	62.6	67.4	19.0	0.1	99.6	0.000
SDG 8	Decent Work and Economic Growth	3,749	65.7	65.5	11.1	33.2	91.8	0.000
SDG 9	Industry, Innovation, and Infrastructure	3,749	31.2	20.9	27.3	0	99.1	0.000
SDG 10	Reduced Inequalities	3,733	60.2	65.7	26.6	0	100	0.000
SDG 11	Sustainable Cities and Communities	3,749	68.8	74.6	18.8	13.8	99.8	0.000
SDG 12	Responsible Consumption and Production	3,749	84.6	88.4	13.0	46.7	98.8	0.000
SDG 13	Climate Action	3,749	80.0	89.4	22.5	0.0	99.9	0.000
SDG 14	Life Below Water	3,709	63.0	62.6	9.5	29.0	89.7	0.000
SDG 15	Life on Land	3,749	64.2	64.1	13.2	27.1	97.9	0.000
SDG 16	Peace, Justice, and Strong Institutions	3,749	65.6	65.6	14.0	27.5	95.8	0.000
SDG 17	Partnerships for the Goals	3,749	57.0	57.0	12.7	19.4	100	0.000

The dependent variables in each respective model are the countries' overall SDG scores and their performances in each of the 17 SDGs. This data is taken from the database which accompanied the 2022 Sustainable Development Report. Data is provided on 163 countries' performances on the sustainable development goals tracked over the period from 2000 to 2022. Both an overall score, which is the simple average of the individual SDG scores for the 17 Goals, and the individual SDG scores are reported. Each of the 17 Goals are scored over the range 0 to 100 (best). Descriptive statistics are provided in table 1.

The focal explanatory variables are the countries' scores on each of UNCTAD's PCI components, representing their performance in enhancing each of the eight productive capacities. The PCI covers 193 economies over the period 2000-2018, with the set of productive capacities and their specific combinations mapped across 46 indicators. Countries with lower productive capacities possess an index score closer to zero, while those with high productive capacities have index scores closer to 100[9]. The components of the PCI are as follows:

- Human Capital, which captures the education, skills and health conditions possessed by the population, and the overall research and development integration in society through the number of researchers and expenditure on research activities. Gender is reflected by the fertility rate.
- Natural Capital, which reflects the availability of extractive and agricultural resources, including rents generated from the extraction of the natural resource, less the cost of extracting the resource.
- Energy, which measures the availability, sustainability, and efficiency of power sources.
- Transport, which measures the capability of a system to take people or goods from one place to another. It is defined as the capillarity of roads, railway networks, and air connectivity.
- Information and Communication Technology, which reflects the accessibility and integration of communication systems within the population and includes fixed lines, mobile phones users, internet accessibility, and server security.
- Institutions, which reflect political stability and efficiency through regulatory quality, effectiveness, criminality, corruption, and terrorism, and the safeguard of freedom of expression and association.

TABLE 2 Descriptive Summary Statistics for the Independent Variables

Variables	Obs.	Mean	Median	Std. dev.	Min.	Max.	Fisher P-value
Productive Capacity Index (PCI) Components							
Human Capital	3,676	47.47	46.10	13.30	18.66	89.13	0.000
Natural Capital	3,676	52.70	51.98	8.62	14.61	96.69	0.000
Energy	3,676	26.73	27.39	7.09	5.61	59.21	0.000
Transport	3,676	16.99	15.51	7.32	4.00	60.59	0.000
ICT	3,676	9.99	7.85	7.41	2.76	86.39	0.000
Institutions	3,676	54.07	51.28	20.07	1.64	99.73	0.000
Private Sector	3,676	76.93	78.22	9.15	37.97	96.87	0.000
Structural Change	3,676	19.10	18.53	6.08	0.96	64.74	0.000
Control Variables							
Age-Dependency	4,997	60.75	55.03	18.19	16.17	111.48	0.000
Inflation Vol.	3,465	1.78	0.88	5.45	0.03	170.55	0.000
Nat. Res. Rents	3,848	6.75	1.57	11.30	0.00	87.46	0.000
Trade Openness	4,286	85.19	71.64	55.21	1.20	863.20	0.000

- Private Sector, which is defined by the ease – time and monetary costs – of cross-border trade, and the support to business through domestic credit, velocity of contract enforcement and time required to start a business.
- Structural Change, which refers to the movement of labour and other productive resources from low-productivity to high-productivity economic activities. This is captured by the sophistication and variety of exports, the intensity of fixed capital and the weight of industry and services on total Gross Domestic Product (GDP).

All eight productive capacities are included in the regressions in both linear and quadratic forms to investigate the possibility of different relationships between the key variables of interest. table 2 summarises the descriptive statistics of the independent variables.[10] All the independent variables are lagged by one year in the regression analysis.

In addition to the focal variables, four control variables are also included in the regressions. These control variables attempt to capture variation in macroeconomic stability, external resilience, and domestic resource availability and capabilities across countries, that could influence countries' progress towards sustainable development.

The influence of macroeconomic instability is captured by price volatility, measured as the standard deviation in countries' quarterly CPI inflation, sourced from the International Monetary Fund (IMF)'s International Financial Statistics. The higher the volatility in this measure, the greater the macroeconomic instability and the slower the development, as the decision-making process of economic agents becomes myopic as economic uncertainty increases.

External resilience is represented by trade openness. Countries with more open trade regimes can export and import goods more freely and have access to resources that lie beyond their national borders. While trade openness can be good for sustainable development, it is also noted that it can be a source of external vulnerability, exposing countries to changing currents in trade flows. It is possible for this variable to have either a positive or negative impact in the regression analysis. Trade openness is measured at the aggregate level and is the sum of exports plus imports of goods and services as a percentage of GDP. It is sourced from the World Bank's World Development Indicators Database and is lagged by one year in the regression analysis.

Domestic resource availability is included in the regressions through two control variables, natural resource rents and the age-dependency ratio. Natural resource rents are measured by the sum of oil rents, natural gas rents, coal rents, mineral rents, and forest rents as a percentage of GDP. This data is sourced from the World Bank's World Development Indicators (WDI). The age-dependency ratio is the non-working age population – the sum of the young population (under the age of 15) and the elderly population (age 65 and over) – as a percentage of the working age population (ages 15 to 64). Countries with high age-dependency ratios are more likely to require proportionately more of the income produced by their working age populations to support both the young and elderly in society and will make less resources available to advance sustainable development goals. This data is sourced from the World Bank's World Development Indicators (WDI).

Results

The regression results in the second column of table 3 show which of the eight productive capacities are key correlates with countries' overall SDG scores. The results indicate that while transport and the private sector did not have statistically significant relationships with the dependent variable, five of the eight indicators which comprise the PCI have an inverted-U relationship with SDG scores. Table 3 shows that Human Capital, Natural Capital, Energy, ICT, and Structural Change all have

TABLE 3 Regression Results

	Overall SDG Score	Individual SDG Goals 1 No Poverty	2 Zero hunger	3 Good Health & Well-Being	4 Quality Education	5 Gender Equality	6 Clean Water & Sanitation	7 Affordable & Clean Energy	8 Decent Work & Economic Growth	9 Industry, Innovation & infrastructure	10 Reduced Inequalities	11 Sustainable Cities & Communities	12 Responsible Consumption & Production	13 Climate Action	14 Life Below Water	15 Life on Land	16 Peace, Justice & Strong Institutions	17 Partnerships for the Goals
Human Capital$_{t-1}$	0.276**	+ve**	+ve**	+ve**	+ve**	+ve**	+ve**	+ve**		-ve**	-ve**	+ve**	+ve**	-ve**	-ve**	-ve**		+ve**
Sq. Human Capital$_{t-1}$	−0.002**		-ve**	-ve**	-ve**	-ve**	-ve**	-ve**		+ve**	+ve**	-ve**	0**	+ve**	+ve**	+ve**		-ve**
Natural Capital$_{t-1}$	0.156**	+ve**	+ve**	+ve*	+ve**	+ve**	+ve**		+ve*	-ve**	-ve**					-ve**		+ve**
Sq. Natural Capital$_{t-1}$	−0.001**	-ve**	-ve**	-ve*	-ve**	-ve**	-ve*			+ve**	+ve**					+ve*		-ve**
Energy$_{t-1}$	0.098**		+ve**	+ve**	+ve**		+ve**	+ve**		-ve**	-ve**	+ve**	+ve**					-ve**
Sq. Energy$_{t-1}$	−0.001**		-ve**	-ve**	-ve**		-ve**	-ve**		+ve**	+ve**	-ve*	-ve**					+ve**
Transport$_{t-1}$	0.004	+ve**		-ve**	-ve**		+ve**		+ve*	-ve**	+ve**		-ve**	-ve**			+ve**	
Sq. Transport$_{t-1}$	0.000	-ve**			+ve**		-ve**			+ve**	-ve**		+ve**	+ve**	+ve**		-ve**	+ve**
ICTt-1	0.461**	+ve**	+ve**		+ve**	+ve**	+ve**		+ve**	+ve**	+ve**	-ve**		-ve**	+ve**	+ve**	+ve**	
Sq. ICT$_{t-1}$	−0.011**	-ve**	-ve**	-ve*	-ve**	-ve**	-ve**		-ve**	-ve**	-ve**	+ve**		+ve**	-ve**	-ve**	-ve**	+ve**
Institutionst-1	0.065**	+ve**	+ve*	+ve**			+ve**	+ve**	-ve**			+ve**	+ve**	+ve**				
Sq. Institutionst-1	0.000**				-ve**		-ve**	-ve**	+ve**			-ve**	0**	-ve**		+ve**	+ve**	+ve*
Private Sectort-1	0.044		+ve**		-ve**	+ve**	+ve**	+ve**	+ve**		+ve**					-ve**		-ve**
Sq. Private Sectort-1	0.000		-ve**			-ve**	-ve**	-ve**	-ve**		-ve**	+ve**				+ve**		+ve**
Structural Changet-1	0.126**		-ve**	+ve**	+ve**	+ve**		+ve**	+ve**		-ve**				+ve**	+ve**		

Continued on the next page

TABLE 3 *Continued from the previous page*

	Overall SDG Score	Individual SDG Goals																
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
		No Poverty	Zero hunger	Good Health & Well-Being	Quality Education	Gender Equality	Clean Water & Sanitation	Affordable & Clean Energy	Decent Work & Economic Growth	Industry, Innovation & infrastructure	Reduced Inequalities	Sustainable Cities & Communities	Responsible Consumption & Production	Climate Action	Life Below Water	Life on Land	Peace, Justice & Strong Institutions	Partnerships for the Goals
Sq. Structural Changet-1	−0.002*		+ve**	-ve**	-ve**	-ve**	+ve*	-ve**	-ve**		+ve**				-ve**	-ve**		
Dep_lag	−0.029**	-ve**		-ve**	-ve**	-ve**	-ve**	-ve**				+ve**	-ve**	+ve**	+ve**	+ve**	+ve**	-ve**
Inf_Std_Q_lag	0.000		-ve**			+ve**						-ve**			+ve**			
Ln_NRR_lag	−0.074*		+ve**			-ve**			+ve**	-ve**							-ve**	
Trade_lag	0.009**			+ve**	+ve**	+ve**		-ve**		+ve**					+ve**	+ve**		+ve**
Trend	0.181**																	
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	−324.78**			-ve**	-ve**	-ve**	-ve**	-ve**	-ve**	-ve**		-ve**	+ve**	-ve**	-ve**	-ve**		

NOTE ** if significant at 5% level; * if significant at 10% level

Hausman	0.000
Breusch-Pagan	0.000
Wooldridge	0.000
Frees	25.120

a positive impact on SDG scores for countries with low levels of productive capacity in these areas. However, for countries with high levels of capacity in these areas, further increases in capacity could lead to lower SDG scores[11]. In contrast, Institutions has a positive quadratic relationship with SDG Score. This indicates that there is a positive relationship between institutions and SDG Score for countries with low institutional capacity, as well as for countries with high institutional capacity. This suggests that irrespective of a country's current level of institutional capacity, there is potential for its overall SDG performance to be enhanced with improved institutional capacity.

To further elucidate these relationships, the remaining columns of table 3 present the summarized results of the regression models in which each of the individual SDGs was iteratively included as the dependent variable, and the unpacked components of the PCI were included, along with the control variables, as the independent variables. The statistically significant relationships between the SDGs and the respective productive capacities are highlighted[12]. It should first be noted that each of the 17 SDGs had multiple statistically significant relationships with multiple components of the PCI. This underscores the importance of considering different aspects of countries' productive capacity in any discussion on the SDGs. However, nuanced analyses are critical, particularly for SIDS and LDCs, which are resource-constrained developing countries. They must be very strategic and highly prioritized in their policy efforts towards sustainable development. Analyses of this nature enable such countries to focus on the policy interventions that allow them to have the greatest impact in multiple areas. Table 4 is quite instructive in this regard, as it visually illustrates how the panel regression results produced in this paper can be useful to developing country policymakers and their international development partners.

In this table, for each productive capacity, the statistically significant relationships that are more likely to produce enhancements in SDG performance are colour-coded green and listed first. These include positive linear and quadratic relationships between the SDG and productive capacity being considered. Inverted-U relationships with the PCI components are also coded green, based on the reasonable assumption that SIDS and other vulnerable groups of countries are likely to have low levels of productive capacity. The relationships that are coded red are the ones for which negative linear and quadratic relationships were derived. U-shaped relationships are coded pink, and are placed towards the bot-

TABLE 4 Significant Relationships between Components of PCI and Individual SDGs*

Human Capital	Natural Capital	Energy	Transport	ICT	Institutions	Private Sector	Structural Change
1	8	2	8	1	1	2	3
12	1	3	1	2	2	5	4
2	2	4	6	4	3	6	5
3	3	6	10	5	12	7	7
4	4	7	16	6	6	8	8
5	5	11	2	8	7	10	14
6	6	12	14	9	11	11	15
7	17	9	4	10	13	15	6
11	9	10	9	14	15	17	2
17	10	17	12	15	16	4	10
9	15		13	16	17		
10			3	17	8		
13				11	4		
14				13			
15				3			

Key

- +ve Linear
- Inverted-U
- +ve squared term only
- U-shaped
- -ve squared term only
- -ve Linear

NOTE *Corresponding SDGs are shown in each cell of the table.

tom of the table, based on the previously mentioned assumption regarding SIDS and other vulnerable groups of countries.

Most of table 4 is green-coded, highlighting the important role that improving productive capacities can play in precipitating enhanced SDG performance. Private Sector, Structural Change, Transport, Energy and Natural Capital were shown to have green-coded relationships with over a third of the 17 SDGs. Three productive capacities had green-coded relationships with more than half the SDGs. ICT, Institutions and Human Capital had green-coded relationships with 12, 11 and 10 of the SDGs, respectively.

The results suggest that improvements in institutional capacity provide the greatest opportunity for widespread, unmitigated improvement in SDG performance. This is because four of the 11 green-coded relationships between institutional capacity and the SDGs are positive linear or quadratic (implying that irrespective of a country's level of institutional capacity, performance in SDGs 1, 2, 3 and 12 will improve with enhanced institutional capacity). Human capital has a similar relationship with SDG-1 (No Poverty) and SDG-12 (Responsible Consumption and Production), and Natural Capital and Transport both have a similar relationship with SDG-8 (Decent Work and Economic Growth).

Most of the green-coded relationships, however, have an inverted-U shape. Eleven of the 12 green-coded relationships with ICT capacity have this shape, indicating that for countries with low levels of such capacity, enhanced ICT capacities can yield positive outcomes in 11 SDGs. Human Capital has inverted U shaped relationships with eight SDGs, similarly, indicating that countries with low human capital are likely to have improved SDG performance as such capacity is enhanced. Natural Capital, Energy and Structural Change each have seven such relationships, Private Sector has six, and Transport and Institutions both have four such relationships. These inverted U-shaped relationships dominate the results, with all SDGs exhibiting such a relationship with at least one of the components of the PCI. The dominance of these results highlights the dynamic nature of the relationship between productive capacities and the SDGs, as consideration must be taken of the countries' extant level of each productive capacity when seeking to ascertain its likely relationship with SDG performance. In this respect, our results support and elucidate the findings derived in UNCTAD (2021b), Oluc et al. (2023), and Xin et al. (2023).

The results also highlight the SDGs which are likely to be adversely impacted by countries' efforts to enhance the respective productive capacities, as reflected in the pink- and red-coded relationships. As an example, Human Capital had pink-coded relationships with five of the goals. The results indicate that SDGs 9, 10, 13, 14 and 15 had U-shaped relationships with human capital, so, as countries with low levels of human capital sought to improve capacity in this area, worsened performance in these SDGs could be exhibited. Similar, pink-coded relationships with one or more SDGs are evident for each of the components of the PCI. This suggests that for varied SDGs, even though improvements in productive capacities can yield enhanced SDG performance, this will only occur when the countries are well-endowed with such capacities. When countries have low levels of such capacities, efforts to increase them are likely to be associated with worsened performance in some SDGs. This reflects the nuanced relationship between productive capacities and SDG performance and highlights the trade-offs that must be considered as countries seek to grow and develop. This is in line with studies such as those by Ravallion (2020), Sharmin and Tareque (2018), and Delabre, Alexander, and Rodrigues (2020), which highlight the social and environmental trade-offs faced by poor countries seeking economic growth.

Of the 27 relationships that were pink- and red-coded, ten are with SDGs related to the environment, nine are with social sustainability SDGs, and six are with SDGs related to economic development. Of the ten pink- and red-coded relationships between productive capacities and the SDGs related to the environment, nine were pink. These U-shaped relationships strongly suggest that countries seeking to build productive capacities from very low levels often have to do so at the expense of worsened environmental performance in specific areas, at least temporarily. The upshot of these types of relationships is that once productive capacities increase beyond a certain threshold, further improvements will yield enhanced environmental performance. These results lend support to the Environmental Kuznets Curve (EKC) theory, with the early stages of development associated with environmental deterioration being characterized by low levels of productive capacity, and the level of development beyond which further increases in development result in environmental improvement being characterized by high levels of productive capacity.

It is also noteworthy that improvement in institutional and energy capacities are the only two components of the PCI for which the results do not highlight any downside risks for environmental performance for countries with low levels of capacity in both areas. This is particularly instructive for the energy sector, as it suggests that recent efforts in such countries to improve energy capacity are largely being conducted in an environmentally responsible manner. This may be due to the rapid advances in variable renewable energy technologies that Arndt et al. (2019) assert developing countries are well positioned to take advantage of.

Of the nine pink- or red-coded relationships between productive capacities and the SDGs related to social sustainability, four were red. SDG-3 (Good Health and Well-being) had a statistically significant negative relationship with Transport, as well as with squared-ICT (albeit at only the 10% level of significance). SDG-4 (Quality Education) had statistically significant negative relationships with Private Sector capacity, as well as with squared-Institutions. These relationships, particularly between transport and SDG-3 and the private sector and SDG-4, merit further investigation to identify the factors which are driving the association between the variables.

Also noteworthy is the fact that four of the five pink-coded relationships between productive capacities and the social sustainability indicators involved SDG-10 (Reduced Inequality). Human Capital, Natural Capital, Energy and Structural Change all had U-shaped relationships with Reduced Inequalities. These results suggest that as countries with low capacities in these areas seek to increase their capacities, careful attention must be placed on the issue of income inequality. Advancement in human and natural capital, energy capacity and structural change can worsen inequality in a society. Similar results were derived by Lee and Lee (2018), who found that, inter alia, higher per capita income and faster technological progress (typically associated with higher levels of human capital and structural change) tend to make income distribution more unequal.

The results also indicate that four of the six pink-coded relationships between productive capacities and the SDGs targeting economic development involve SDG-9 (Industry, Innovation, and Infrastructure). U-shaped relationships were exhibited between this goal and Human Capital, Natural Capital, Energy and Transport. The upward-sloping part of this relationship is easily understood, as high levels of these productive capacities are needed to foster resilient infrastructure, sustainable industrialization, and innovative activities. Note, however, that the results indicate that improving such capacities when the levels of human and natural capital, energy and transport are low can be inimical to this goal. This is because while improving productive capacities from low levels typically results in increases in the quantity of production, SDG-9 requires resources to be dedicated to clean, innovative, and sophisticated production techniques. This is unlikely to be the primary focus in countries with low levels of human and natural capital, and energy, and weak transportation capacity. The basic improvements yielded at low levels of capacity are likely to be in industries and infrastructure that are not highly resilient and innovative, again highlighting the prevalent trade-offs when countries seek to grow and develop.

There is thus adequate evidence from the results to reasonably caution that as countries pursue enhancement of their productive capacities, attention must be placed on measures to mitigate adverse environmental consequences and worsened income inequality, and to catalyse clean, innovative production even when seeking to develop from low capacities. The results also indicate that a focus on enhancing institutional and ICT capacities, along with human capital, will yield the most widespread improvement in SDGs, particularly for countries with low capacities in ICT and human capital. For countries seeking to target improvement in particular SDGs through productive capacity enhancement, the results further highlight the alternate paths that could be pursued. For some of the goals, for example SDG-6 (Clean Sanitation and Water), SDG-5 (Gender Equality), SDG-4 (Quality Education) and SDG-2 (Zero Hunger), between five and six paths are available for countries with low levels of productive capacity. For other goals, such as SDG-9 (Industry, Innovation and Infrastructure) and SDG-13 (Climate Action) the results only revealed one relationship that yielded improved performance for countries with low capacities (enhanced institutional capacity for SDG-13 and enhanced ICT capacity for SDG-9.)

This is very instructive, as it suggests that countries which are performing generally poorly in meeting many of the SDG targets could focus policy attention on enhancing capacity in one or a few key areas to maximize broad-based impact. Alternatively, countries with a need to focus intensively on one or a few specific SDGs could focus on the productive capacities that have been shown to be positively associated with that/those goals.

Sensitivity Analysis – Exploring the Impact of the Global Financial Crisis on the Stability of the PCI-SDG Relationships

Since the period for this study extends to 2018, we test whether global crisis events, notably the global financial crisis (GFC), had an impact on the relationship between productive capacities and sustainable development. Beginning on the 9th of August 2007, global financial markets were in a state of distress, with contagion spreading rapidly across advanced economies and having pervasive impacts globally over the following years. Markets and economies displayed the remnants of the global economic crisis for many years after the initial years of the shock, affecting economic growth and thus narrowing the space for advancing sustainable development.

We ran the model on periods before and after 2007 to examine the impact that the GFC had on the stability of the relationships between each of the productive capacity elements and sustainable development.

TABLE 5 Sensitivity Analysis – Overall SDG Score

	Full model Coeff.	Pre GFC Coeff.	Post GFC Coeff.
HCap_lag	0.276**	0.205**	0.166**
HCap_sq_lag	−0.002**	−0.002**	−0.001**
NCap_lag	0.156**	−0.169*	0.173**
NCap_sq_lag	−0.001**	0.001	−0.001**
Energy_lag	0.098**	0.093	0.105**
Energy_sq_lag	−0.001**	−0.002	−0.001**
Trans_lag	0.004	0.047**	0.02
Trans_sq_lag	0.000	0.000	0.000
ict_lag	0.461**	0.276**	0.633**
ict_sq_lag	−0.011**	−0.007**	−0.014**
Inst_lag	0.065**	−0.030**	0.047**
Inst_sq_lag	0.000**	0.000**	0.000
PS_lag	0.044	−0.068	0.109**
PS_sq_lag	0.000	0.000	−0.001**
StCh_lag	0.126**	0.094**	0.121*
StCh_sq_lag	−0.002*	−0.002*	−0.001
Dep_lag	−0.029**	0.001	−0.063**
Inf_Std_Q_lag	0.000	0.004**	−0.039**
Ln_NRR_lag	−0.074*	0.006	−0.152**
Trade_lag	0.009**	0.002	0.008**
Trend	Yes	Yes	Yes
Time Effects	Yes	Yes	Yes
Constant	Yes	Yes	Yes

NOTE ** if significant at 5% level; * if significant at 10% level

The results are shown in table 5 in which the full model is compared to pre-crisis and post-crisis variants of the model, where countries' overall SDG score is utilized as the dependent variable. Time trend, time and country fixed effects, and a constant term, are included in the models.

The results indicate that of the six productive capacities that had statistically significant relationships with SDG score in the full model:

- one, institutions, had a different type of relationship in the pre- and post-crisis periods, which also differed from the relationship exhibited in the full model;

TABLE 6 Significant Relationships between Components of PCI and Individual SDGs Pre- and Post-Crisis*

Human Capital		Natural Capital		Energy		Transport		ICT		Institutions		Private Sector		Structural Change	
Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
2	12	11	11	7	5	14	1	5	17	5	3	3	9	3	1
3	2	2	1	2	4	3	8	8	1	10	4	6	1	6	3
4	3	6	2	4	6	6	15	9	2	8	2	16	2	16	4
5	4	9	4	6	7	7	16	10	3	2	7	8	6	2	6
6	5	10	5	13	11	9	2	15	4	7	11	9	8	4	8
7	6	15	15	9	12	8	9	16	6	15	12	2	10	5	12
11	7	16	17	16	14	15	16	17	7	16	13	15	14	7	13
14	8		9	3	15	11	4	3	8	6	16		16	13	16
16	1		13	14	1		12	7	9		5		13	17	10
9	9			17	17		5	11	10		6		15	14	
8	16						6	13	12		8		17	15	
10	15							4	13		14				
	10							6	5		17				
	13								11						
	14								14						

Key
- +ve Linear
- Inverted-U
- +ve squared term only
- U-shaped
- -ve squared term only
- -ve Linear

NOTE *Corresponding SDGs are shown in each cell of the table.

- one, structural change, exhibited a similar relationship in the pre-crisis period as in the full model, but a changed relationship for the squared term in the post-crisis period;
- two, natural capital and energy, retained the relationship exhibited in the full model in the post-crisis period, but did not exhibit a similar relationship in the pre-crisis period; and
- two, human capital and ICT, had stable inverted U-shaped relationships with SDG score in the pre- and post-crisis periods.

We next ran the regressions for the pre- and post-crisis periods in which the scores on each of the 17 SDGs are iteratively included as the dependent variable. The summarized, colour-coded results are presented in table 6[13]. The light-green-coded inverted U-shaped relationships between the respective productive capacities and the individual SDGs again dominate the results, irrespective of whether the pre- or post-crisis period is being considered. Notwithstanding this, as would be expected, the nature of the individual relationships between specific capacities and SDGs has been impacted by the GFC. Some capacities, such as natural capital, energy, institutions, and the private sector, had considerably more inverted U-shaped relationships with SDGs in the post-crisis period than in the pre-crisis period. Others, such as transport and structural change, had more pink- and red-coded relationships with SDGs in the post-crisis period than in the pre-crisis period. And others, notably human capital and ICT, exhibited remarkable stability in their relationships with the SDGs, in spite of the GFC's deep and far-reaching impacts.

The stability of the relationships between human capital and ICT with countries' overall SDG score and with several of the individual SDGs, in the face of a major, disruptive global event, is noteworthy, and highlights the potential stable impact that enhancing such productive capacities can have on countries with low levels of human capital and ICT. The dominance of inverted U-shaped relationships between productive capacities and SDGs in spite of the GFC further supports the importance to sustainable development of the role of enhancing such capacities in countries where they are low. The divergence between the results in the pre- and post-crisis periods for several of the relationships highlights the disruptive nature of the GFC, and points to the need for further research to elucidate the specific channels through which crisis impacts are felt and can be alleviated. The recent COVID-19 global pandemic provides another opportunity for future research to focus on the nuances of the relationship between productive capacities and SDGs, as enhanced economic resilience and economic transformation increasingly become crucial elements of countries' development strategies.

Conclusions

The investigation of the relationships between each of the eight component indicators of the Productive Capacity Index (PCI) with the individual Sustainable Development Goals (SDGs) yields nuanced conclusions that ought not be ignored. The fact that each of the 17 SDGs had statistically significant relationships with multiple components of the PCI underscores the importance of considering the different aspects of countries' productive capacity in any discussions on the SDGs. Such nuanced analyses enable the Least Developed Countries (LDCs), Small Island Developing States (SIDS) and other vulnerable economies to focus on the policy interventions which allow them to have the greatest impact in multiple areas, or to target critical areas with specifically designed interventions that are most likely to create the desired outcomes. As an example, for countries with low capacities in ICT, Institutions and Human Capital, targeted improvements in those areas can yield positive outcomes in between 10 and 12 of the SDGs.

The analyses presented in this paper also allow such countries to better prepare for the likely adverse effects of policy interventions on vulnerable areas. Over a third of the statistically significant relationships that were categorized as having potentially adverse effects on the affected SDGs were related to the environment, with SDG-13 (Climate Action) and SDG-15 (Life on Land) being particularly vulnerable to adverse relationships with multiple productive capacities. The results also suggest that as countries pursue enhancement of their productive capacities, careful attention must be placed on issues of income inequality and the need to encourage resilient, innovative production. The model and results presented herein thus provide a useful template for use in policy settings, both in developing country governments and their international devel-

Notes

1 The productive capacities included in the PCI are: Natural Capital, Human Capital, Energy, Transport, ICT, Institutions, Private Sector, and Structural Transformation.

2 The challenge, however, is that while many of the theoretical and empirical studies have focused on one or a few productive capacities, far fewer attempt to holistically measure and examine countries' productive capacities generally and assess the impact of such capacities on achieving sustainable development.

3 First released in 2021.

4 Foye (2022), however, highlighted the nuanced nature of this relationship, as her results indicated that climate change negatively influenced food prices in Nigeria. She concluded that only concerted and consistent climate change mitigation strategies can precipitate lower food prices through a green economy.

5 The Pesaran test results confirmed the findings of the Frees test and are available upon request.

6 It should also be noted that the Newey-West and Driscoll-Kraay results are similar. As highlighted in Hoeschle (2007), this may indicate that the level of cross-sectional dependence is low. Therefore, the results of the first-generation unit root tests appear to be trustworthy. These results can be provided by the authors upon request.

7 The results for the other unit root tests are available upon request.

8 The Pesaran and Yagamata slope heterogeneity test was conducted. However, it did not perform well due to the finite time dimension of the panel. Both Pesaran and Yagamata (2008) and Bersvendsen and Ditzen (2021) argue that the test lacks power when T is small.
9 See https://unctad.org/topic/least-developed-countries/productive-capacities-index
10 Pair-wise correlations between the SDGs and PCI components can be provided by the authors upon request.
11 All but one of those relationships were significant at the 5% level. While Structural Change had a positive relationship with SDG Score that was significant at the 5% level, the negative relationship between squared Structural Change and SDG Score was only significant at the 10% level.
12 The full regression results can be provided by the authors upon request.
13 The full regression results can be provided by the authors upon request.

opment partners, as more effective targeting of resources and policy interventions for achieving the SDGs is pursued.

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