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Financial Development, Financial Globalization, Energy Consumption, and Environmental Degradation as Long-Run Determinants of Economic Growth: Causal Dynamics, Cointegration, and Distributional Evidence from Panel Data

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Abstract: Using an annual panel of 142 economies over 1993–2020, we estimate long-run elasticities between real income per capita and financial development, financial globalisation, energy consumption, and ecological pressure. Under cross-sectional dependence and slope heterogeneity, CIPS unit-root tests confirm I(1) behaviour; Westerlund bootstrap cointegration tests establish a stable long-run equilibrium; and five heterogeneous panel estimators – MG-AUG, CCE-MG, CCE-GMM, DCCE-MG, and CS-ARDL – provide cross-estimator robustness. All four elasticities are positive: energy use and ecological pressure display the largest long-run associations with income, while finance and globalisation exhibit smaller positive elasticities once global common shocks are controlled for. Method-of-moments quantile regression reveals that finance and globalisation effects are stronger at lower income quantiles and attenuate upward, while energy remains positive throughout the distribution. Dumitrescu–Hurlin (2012) causality tests provide evidence of feedback linkages between GDP per capita and the four drivers, with the strongest bidirectional evidence for ecological pressure and weaker or marginal reverse-causality evidence for finance, energy, and financial globalisation. These results add directional information that cointegration tests alone cannot provide. Policy implications emphasise energy decarbonisation, cautious finance-led growth claims, and directing global capital toward sustainable investment.

Keywords: economic growth; financial development; financial globalization; energy consumption; environmental degradation.

JEL classification: C23; C32; F43; Q43; Q53.

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1. INTRODUCTION

Long-run income differences across countries are shaped by a set of structural forces that operate simultaneously and interact in ways that single-nexus analyses are ill-equipped to capture. Financial intermediation mobilises savings and allocates capital toward productive uses; financial globalisation widens the frontier of risk sharing and external financing; energy use underpins industrial production and capital accumulation; and ecological pressure represents the environmental cost embedded in growth trajectories. Taken in isolation, each of these relationships has attracted an extensive empirical literature. Taken jointly – as they must be when informing policy in an integrated world economy – the evidence remains fragmented, often sensitive to sample coverage, proxy choice, and the treatment of global common shocks. This paper addresses that gap directly.

The finance-growth relationship is the most studied of the four. Theoretical work establishes that deeper financial systems reduce information and transaction costs, enhance screening and monitoring, and allocate capital more efficiently toward high-return investments (Levine, 1997; Beck *et al.*, 2000). Yet the empirical magnitude of this effect remains contested: it depends critically on what 'financial development' actually measures. Composite indices that capture depth, access, and efficiency of both institutions and markets produce different estimates than simple banking ratios, and the effect can exhibit diminishing returns or even reverse once financial systems become very large (Svirydzenka, 2016; Purewal and Haini, 2022).

Financial globalisation adds a cross-border dimension: it can supplement domestic savings, lower the cost of capital, and transmit technology and governance improvements through foreign direct investment and portfolio flows (Kose *et al.*, 2010; Obstfeld, 2020). However, premature or poorly sequenced integration also amplifies exposure to sudden stops and external financial cycles, so the growth payoff is conditional on domestic institutional quality and macroprudential capacity (Alfaro *et al.*, 2004; Gygli *et al.*, 2019). The KOF index distinguishes de jure openness from de facto integration, enabling separation of policy stance from its realised consequences.

Energy use underpins industrial production and capital accumulation, and a positive long-run association between energy and income is consistent with both the energy-led growth hypothesis and the growth-led energy demand hypothesis (Ozturk, 2010; Stern, 2011). The direction of causality is itself an open question, which is precisely why explicit panel causality testing adds value beyond cointegration analysis. Finally, ecological pressure—measured here by the consumption-based ecological footprint rather than territorial CO_2 emissions—reflects the full resource demand associated with a country's consumption pattern. A positive long-run association between income and ecological pressure is historically well-documented and reflects incomplete decoupling; it is an empirical observation, not a policy endorsement (Grossman and Krueger, 1995; Borucke *et al.*, 2013).

The existing literature presents mixed and inconclusive findings regarding the relationship between energy consumption, financial development, environmental degradation, and economic growth. Most studies have focused on the effects of energy, financial development, and economic growth on environmental degradation, with less emphasis on how financial development, energy use, and environmental degradation jointly influence economic growth, particularly in the long term. Recent contributions have begun to address parts of this gap. Odhiambo (2023) reviews international evidence on the finance-

growth relationship and highlights persistent sensitivity of findings to country selection and estimator choice. Singh *et al.* (2023) document asymmetric and regime-dependent finance-growth effects, suggesting that credit deepening supports growth up to a threshold before diminishing returns set in. He and You (2024) find that convergence in financial development across countries conditions the growth payoff from finance, implying that cross-country heterogeneity is a first-order empirical concern rather than a nuisance. On the environmental side, Zhou *et al.* (2024) show that environmental regulation moderates the finance-footprint link in regional panels, and Toumi (2025) documents quantile heterogeneity in ecological footprint responses across income levels. Notwithstanding these advances, no study in this strand has combined multi-dimensional finance, financial globalization, energy use, and ecological pressure in a single long-run framework that explicitly tests for both cointegration and causality under cross-sectional dependence and slope heterogeneity, leaving a clear gap this paper fills. Moreover, according to Obstfeld (2020, 2021), the significance of financial development depends on the degree of financial globalization within an economy. To our knowledge, there has been limited research on the role of financial globalization in the finance–energy–environmental degradation–economic growth nexus.

This paper makes four specific contributions to the existing literature. First, it is one of the few studies to simultaneously examine the joint long-run impact of financial development, financial globalization, energy consumption, and environmental degradation on economic growth in a unified global framework, rather than treating each nexus in isolation. Most existing studies focus on bilateral or partial relationships, leaving open the question of how these forces interact when modelled jointly. Second, the paper employs five complementary heterogeneous panel estimators – MG-AUG, CCE-MG, CCE-GMM, DCCE-MG, and CS-ARDL – that explicitly account for cross-sectional dependence and slope heterogeneity. Using multiple estimators simultaneously serves as an internal robustness strategy: consistent results across all five methods provide stronger evidence than any single estimator could on its own, particularly in panels subject to global common shocks. Third, it uses the ecological footprint per capita as the baseline environmental proxy rather than CO_2 emissions, providing a consumption-based measure of ecological pressure that captures resource use beyond territorial emissions and reflects total environmental demand associated with living standards. Fourth, and distinctively from most cointegration studies in this nexus, the paper provides explicit panel causality evidence via the Dumitrescu and Hurlin (2012) test, establishing the direction of causal linkages between each driver and economic growth. This allows us to determine not merely whether variables share a long-run relationship, but whether and how they drive each other, yielding actionable policy insights. Together, these contributions provide a more complete and methodologically robust assessment of the long-run growth nexus than prior studies.

The remainder of this paper is organized as follows. Section 2 reviews the relevant literature and distils testable expectations. Section 3 describes the data. Section 4 presents the econometric strategy and results. Section 5 concludes with policy implications.

2. LITERATURE REVIEW

2.1. Financial development and economic growth nexus

The theoretical case for a positive finance–growth relationship rests on several complementary mechanisms. Deeper and more efficient financial systems reduce information and transaction costs, enabling effective mobilisation of savings (Stiglitz and Weiss, 1983; Diamond, 1984), more productive allocation of capital toward higher-return projects (Hicks, 1969; Greenwood and Jovanovic, 1990), and better monitoring of investments that alleviates agency problems and lowers corporate governance costs (Bencivenga and Smith, 1993). These mechanisms were first articulated systematically by Nasse (2016) and Schumpeter (1911); Schumpeter (1934), and formalised in the financial intermediation literature following McKinnon (1974) and Cole and Shaw (1974). The finance–growth relationship therefore has deep theoretical roots, even as its empirical magnitude remains contested.

Additionally, well-developed financial intermediaries support technological progress by rewarding entrepreneurs (King and Levine, 1993). Moreover, Levine (1997) suggests that financial institutions also facilitate trading, portfolio diversification, hedging, and risk reduction, alongside their traditional role in enabling transactions of goods and services (Levine, 2005; Beck *et al.*, 2010; Svirydzenka, 2016). These financial operations are rather important for influencing the behavior of savings and investments and defining how efficiently the available funds are distributed. Thus, financial development is vital in influencing the processes of the accumulation of human and physical capital as well as total productivity—all three key factors that stimulate the growth of an economy (Levine, 1997). Furthermore, the allocation of credit within the financial system creates a connection between the financial and real sectors. This channel supports firms by financing their working capital needs and investments in fixed capital, with the former enhancing production and the latter improving the productivity of the real sector (Das and Guha-Khasnobis, 2008). Finally, through the mitigation of information discrepancies and credit constraints, financial development promotes the efficiency with which financial systems can manage risks, minimize information costs, absorb, or cushion economic shocks and dampen the flanks of business cycles through the financial accelerator, as put forward by Bernanke *et al.* (1999). The financial sector has the potential to contribute to the stabilization of macroeconomic fluctuations and imbalances while also aiding in the reduction of inequality.

However, the widely accepted view of a positive relationship between financial development and economic growth has been questioned by some scholars. For instance, Robinson argued that finance has a relatively small influence on economic growth and is, instead, a consequence of the growth process itself. This notion was further supported by Van Wijnbergen (1983) and Buffie (1984), who suggested that the expansion of financial institutions could draw borrowers away from informal markets, ultimately reducing credit availability and impeding economic growth. Similarly, Lucas (1988) expressed a comparable sentiment, asserting that financial markets play only a modest role in fostering broader economic development.

In the literature, various measures of financial development have been employed, which can broadly be categorized into two groups: financial institutions and financial markets. Common proxies for financial institutions include the ratio of the banking sector's liquid liabilities to GDP (Levine, 1997; Adusei, 2013), the ratio of commercial bank assets to the

total assets of deposit money banks and central banks (Levine, 1997), the credit-to-deposit ratio (Adusei, 2013), and domestic credit to the private sector as a percentage of GDP (Levine, 1997; Levine and Zervos, 1998; Saci *et al.*, 2009; Adusei, 2013). For financial markets, widely used proxies include the total value of listed shares on the stock market as a percentage of GDP (Levine and Zervos, 1998), the total value of shares traded on a stock exchange as a percentage of GDP (Levine and Zervos, 1998; Saci *et al.*, 2009), and the ratio of the total value of shares traded to the average real market capitalization (Levine and Zervos, 1998; Levine *et al.*, 2000; Saci *et al.*, 2009). The majority of empirical studies indicate a positive relationship between financial development and economic growth. However, financial development is a multifaceted process, reflecting the evolution of financial sectors and the increasing complexity of financial systems (Čihák *et al.*, 2012). To address this complexity, Svirydzenka (2016) introduced a more comprehensive financial development proxy based on the functions of financial systems, institutions, and markets, considering their depth, access, and efficiency. This measure builds on the suggestions of Sahay *et al.* (2015) and the earlier work of Čihák (Čihák *et al.*, 2012; Sahay *et al.*, 2015; Svirydzenka, 2016).

2.2. Financial globalization and economic growth nexus

A significant theory regarding the influence of financial globalization on economic growth is the neoclassical growth model (Lucas, 1988). This model suggests that financial globalization facilitates the global allocation of capital flows from capital-abundant developed economies to capital-scarce economies, where the return on capital is higher. These inflows are expected to supplement the limited domestic savings in capital-deficient economies and, by reducing the cost of capital, promote increased investment. Certain types of financial inflows, such as foreign direct investments (Dunning, 1993; Borensztein *et al.*, 1998) and portfolio reallocations (Levine and Zervos, 1998) can foster technology spillovers and serve as channels for transferring managerial and organizational expertise from more advanced economies. Additionally, other studies emphasize the importance of indirect channels, suggesting that the positive impact of financial globalization on growth arises not only from direct financial flows but also from collateral benefits (Kose *et al.*, 2006a; Kose *et al.*, 2006b). These indirect channels include improvements in institutions – broadly defined to encompass aspects such as governance quality and the rule of law – and the enhancement of macroeconomic policy-making.

According to Mishkin (2009), the opening of financial markets to foreign participants fosters financial development and growth by expanding access to capital and reducing its cost for productive investments. However, studies suggest that premature exposure to international capital markets can heighten vulnerability to sudden stops in capital flows unless specific preconditions are met. These preconditions include a minimum threshold of institutional quality, financial market development, and macroeconomic stability (Eichengreen, 2001; Alfaro *et al.*, 2004; Klein and Olivei, 2008). Stulz (2005) finds that globalization can reduce agency problems by lowering the cost of external financing, incentivizing better corporate management. Gourinchas and Jeanne (2005) propose that financial globalization incentivizes better macroeconomic policies by emphasizing their benefits and encouraging reforms. Similarly, Bartolini and Drazen (1997) contend that increased financial openness signals a commitment to stronger macroeconomic policies. Paceskovski (2013) highlight that financial globalization provides substantial advantages for developing countries and emerging markets

by fostering financial sector development and supporting economic growth. However, it also brings risks, particularly the heightened potential for financial crises. Financial globalization enables capital-poor countries to diversify their economies beyond agriculture and natural resources, thereby reducing macroeconomic volatility. However, at more advanced stages, it may lead to increased specialization, making middle-income countries more vulnerable to industry-specific shocks and contributing to greater output volatility (Kose *et al.*, 2006a; Kose and Prasad, 2007; Prasad *et al.*, 2007; Kose *et al.*, 2010). Additionally, heavy reliance on external debt can further expose these countries to fluctuations in global interest rates, amplifying output volatility.

To investigate the features of financial globalization across countries, alternative proxies describing different characteristics of financial integration exist. Foreign direct investment (FDI), characterized by ongoing investments and extended business ties of foreign enterprises, is an important measurement and is recognized for its ability to stabilize the influence of international currency crises (Alfaro *et al.*, 2004; Broner *et al.*, 2013; Broner *et al.*, 2023). Integrating equity and debt securities into portfolio investments enhances financial openness but is often accompanied by increased volatility in capital flows, a characteristic feature of emerging markets (Bekaert *et al.*, 2014; Lane and Milesi-Ferretti, 2018). Obstfeld (Obstfeld, 2020, 2021; Obstfeld *et al.*, 2021) and Jeanne and Rancière (2011) observe that the objective behind central banks' domestic and foreign reserves is to safeguard against outside threats and regulate volatility during financial crises. A report by Avdjiev *et al.* (2021) indicates that gross foreign assets and liabilities depict the overall financial ties of a country, pointing to an increase in global banking networks. In 2009, Kose *et al.* (2006a) developed the financial globalization index (FGI). In line with limitations in cross-border transactional law, the KAOPEN index, which serves as a benchmark for assessing financial growth, is related to research findings that highlight a connection to financial growth (Chinn and Ito, 2008; Quinn *et al.*, 2011). More recently, the Financial Globalization KOF Index, introduced by the Swiss Economic Institute, is an extensive assessment tool that combines real economic activities, such as foreign assets and liabilities, with regulatory constructs, including capital account restrictions, and it summarizes both legal- *de jure* and functional – *de facto*, providing a thorough measurement of the degree of financial globalization (Gygli *et al.*, 2019). The literature primarily suggests that financial globalization plays a positive role in fostering economic growth.

2.3. Energy consumption and economic growth nexus

Energy is a crucial input in the production process, driving industrial activities and playing a key role in technological and economic development. The relationship between energy consumption and economic growth has sparked significant debate, particularly regarding the direction of causality. Specifically, there is ongoing discussion about whether energy consumption acts as a catalyst for economic growth or if it is merely a result of economic growth (Ozturk, 2010). Theoretical discussions around the energy–growth nexus are often framed around two main opposing hypotheses: the energy–led growth hypothesis, in which energy usage generates economic growth by supporting higher production and productivity levels (Cleveland *et al.*, 2004). This view is particularly relevant for industrialized and energy-dependent economies. In contrast, the growth-led energy hypothesis

posits that economic growth leads to increased energy consumption, implying that energy use is a byproduct rather than a driver of economic growth (Narayan and Smyth, 2008).

Empirical research provides inconsistent evidence because of differences in country sample selection, empirical techniques and the time span examined. For example, in the MENA region, Omri (2013) and Kahia *et al.* (2016) reported bi-directional causal relationship between energy consumption and economic growth, using a simultaneous system of equations and a panel VAR approach, respectively. In contrast, (Sadorsky, 2010) found that, in certain emerging markets, economic growth leads to increased energy consumption. Apergis and Payne (2010) reported evidence of both short-term and long-term interactions between energy consumption and economic growth. With respect to BRICS countries' growth and renewable energy use, Pao and Tsai (2010) observed a positive relationship between economic growth and renewable energy use, with unidirectional causality flowing from renewable energy use to economic growth, while also reducing CO2 emissions.

Given this evidence, total primary energy consumption per capita – which aggregates across all fuel types and end uses – is the most appropriate and widely used empirical proxy for the aggregate energy–income relationship in global macro panels, and it is the measure adopted here.

2.4. Environmental degradation and economic growth nexus

Environmental degradation resulting from pollution, such as carbon emissions and resource depletion, presents a complex and often contradictory relationship with economic growth. This connection has garnered significant attention from researchers, who have employed various methods to study the interaction between economic growth and environmental degradation in different countries and regions (Belloumi, 2009; Luzzati and Orsini, 2009; Apergis and Payne, 2010; Belke *et al.*, 2011; Tang and Tan, 2015; Dong *et al.*, 2017; Shuai *et al.*, 2017; Sarkodie and Strezov, 2018; Ma and Cai, 2019; Wang and Dong, 2019; Ike *et al.*, 2020; Sarkodie and Ozturk, 2020; Dong *et al.*, 2023).

There is strong evidence of a relationship between environmental degradation and economic growth; nevertheless, outcomes depend on the periods covered and the sample size as well as upon country selection. Many studies report a negative relationship, where environmental degradation hinders long-term economic growth, as seen in Azam (2016) and Padilla and Serrano (2006), who highlight the harmful effects of pollution and resource depletion on economic growth. In some cases, especially during early industrialization, degradation can have a positive impact, as economic expansion often involves higher emissions and resource use in developing economies (Kahia *et al.*, 2016; Balsalobre-Lorente *et al.*, 2018; Sarkodie and Ozturk, 2020).

Moreover, an increasing number of studies have explored the growth-environment relationship through the lens of the Environmental Kuznets Curve (EKC). The EKC suggests an inverted U-shaped relationship between environmental pollutants and economic growth (Kuznets, 1955). This hypothesis has been supported in various regions, including high-income countries such as those in the Organization for Economic Cooperation and Development (OECD) (Jaunky, 2011; Bilgili *et al.*, 2016), BRICS countries (Dong *et al.*, 2017), developing nations (Narayan and Narayan, 2010), the United States (Sencer Atasoy, 2017), and countries in the Asia-Pacific region.

3. DATA

The analysis uses an annual panel of 142 economies over 1993–2020, yielding 3,976 country–year observations. All variables enter the estimations in natural logarithms so that estimated coefficients are interpretable directly as long-run elasticities. Real income is measured by real GDP per capita in constant 2015 USD from the World Bank World Development Indicators (World Bank, 2021). Financial development is captured by the IMF Financial Development Index (Svirydzenka, 2016), a composite spanning the depth, access, and efficiency of both financial institutions and markets, avoiding the proxy sensitivity that plagues single banking-ratio measures such as private-credit-to-GDP. Financial globalisation is represented by the KOF de jure financial globalisation sub-index (Gygli *et al.*, 2019), which reflects the regulatory stance toward cross-border capital flows and separates openness from its realised magnitude. Energy consumption per capita is from the World Bank WDI (kg of oil equivalent), complemented by EIA data for a small number of missing country-years after unit harmonisation. Environmental pressure is proxied by the ecological footprint per capita (global hectares per person) from the National Ecological Footprint and Biocapacity Accounts (University of York, 2022), a consumption-based measure capturing total ecological demand – food, energy, built land, and waste absorption – broader than territorial CO_2 emissions. Table no. 1 summarises the variables and their sources.

Table no. 1 – Analysis Variables

Symbol	Variables	Unit of measurement	Source
y	Gross Domestic Product per capita	Constant 2015 USD	World Bank (2021)
fd	Financial Development Index	index	IMF (2022)
kof	Financial globalization index *de jure*	index	KOF Swiss Economic Institute
ec	Energy consumption per capita	kg of oil equivalent per capita	World Bank (2021); EIA
efc	Ecological footprint per capita	gha/person	University of York (2022)

Table no. 2 presents descriptive statistics. The wide cross-country dispersion in all variables – especially income, finance, and energy – confirms the appropriateness of heterogeneous-parameter estimation rather than pooled methods.

Table no. 2 – Descriptive statistics of the variables

Variable	Mean	Median	Std. Dev	Min	Max	Obs
y	8.490	8.452	1.456	5.248	11.630	3,976
fd	3.224	3.245	0.736	0.000	4.605	3,976
kof	3.959	4.027	0.408	1.920	4.580	3,976
ec	3.631	3.848	1.496	0.000	6.521	3,976
efc	1.193	1.148	0.566	0.000	3.233	3,976

The sample spans 142 countries over 1993–2020 (3,976 observations). A full list of countries is provided in the Annex.

4. RESULTS

The empirical analysis proceeds in five sequential steps, each motivated by the findings of the preceding one: cross-sectional dependence testing, unit-root testing under dependence, slope homogeneity testing, cointegration testing, and long-run estimation. The general long-run relationship of interest is:

$$y_{it} = f(fd_{it}, kof_{it}, ec_{it}, efc_{it}) \quad (1)$$

The long-term model under estimation is presented in equation (2):

$$y_{it} = \beta_0 + \beta_1 fd_{it} + \beta_2 kof_{it} + \beta_3 ec_{it} + \beta_4\, efc_{it} + \varepsilon_{it} \quad (2)$$

where β_0 is a constant term and the parameters β_1 to β_4 are the respective long-term elasticities for each variable and where ε_{it} is the disturbance term. By referring to the studies in Section 2, the respective long-term elasticities are expected to display positive signs.

In a globally integrated economy, national income, financial systems, energy markets, and environmental conditions are all exposed to common shocks – commodity price cycles, global financial conditions, and major crises – that induce co-movement across countries independently of bilateral linkages. In panel data, this manifests as cross-sectional dependence: residual correlation across units driven by unobserved common factors. Standard first-generation estimators that ignore such dependence produce inconsistent estimates and distorted inference (De Hoyos and Sarafidis, 2006; Pesaran, 2006). The first step of the empirical strategy therefore tests formally for cross-sectional dependence across all series.

We apply a series of tests to examine cross-sectional dependence, including the Breusch-Pagan LM test (1980), the Pesaran scaled LM test (2004, 2021), the Pesaran CD test (2004), the bias-corrected scaled LM test (Pesaran *et al.*, 2008), the Frees test (1995) and the Friedman test (1937). Additionally, we incorporate two advanced methods: the power-enhanced CD+ test (Fan *et al.*, 2015) and the Pesaran & Xie CD* test (Pesaran *et al.*, 2008), to evaluate the null hypothesis of weak cross-sectional dependence against the alternative of strong cross-sectional dependence. The results of these tests, summarized in Table no. 3, reveal statistically significant evidence of cross-sectional dependence across all variables. All test statistics reject the null hypothesis of no cross-sectional dependence at the 1% significance level.

Table no. 3 – Cross-sectional dependence test results

variable	Breusch–Pagan LM	Pesaran scaled LM	Bias-corrected scaled LM	Pesaran CD	Power Enhanced CD+ test	Pesaran & Xie CD*	Frees	Friedman
ypc	186214.71***	1245.26***	1242.63***	349.92***	40543.8***	-1.72*	88.7***	2553***
fd	100191.02***	637.31***	634.69***	246.16***	27972.55***	-2.52***	41.5***	1719.7***
ec	93476.18***	589.86***	587.23***	82.96***	26130.98***	22.78***	40.2***	585.9***
efc	62301.54***	369.55***	366.92***	34.98***	20047.73***	9.67***	24.9***	267.9***
kof	65859.38***	394.69***	392.06***	34.54***	21383.02***	52.75***	24.2***	310.5***

Notes: p- values from the respective Tests, Null Hypothesis no cross sectional dependence,
* p<0.10; ** p<0.05; *** p<0.01

Given the pervasive cross-sectional dependence documented above, conventional first-generation unit-root tests are size-distorted and cannot be relied upon (O'Connell, 1998). The second step therefore employs Pesaran's (2007) CIPS test, a second-generation procedure that augments country-level ADF regressions with cross-sectional averages of the series and its lags, filtering out the common-factor component and yielding valid inference under dependence. The null hypothesis is a unit root for each series; results are reported for levels and first differences under both a constant and a constant-plus-trend specification.

The results from the CIPS unit root test (presented in Table no. 4) show that all the variables are non-stationary at their levels (i.e., they have a unit root, denoted as I(1)). However, after first differencing, the variables become stationary (i.e., I(0)), indicating that they are integrated of order one, or I(1). This finding suggests that the growth process and its key determinants exhibit persistent trends over time, consistent with studies that indicate macroeconomic variables often exhibit unit root properties, especially in the context of long-run data (Maddala and Wu, 1999).

Table no. 4 – 2nd generation unit root test results

CIPS Test Statistic	constant	constant &trend	constant	constant &trend
Variable	**Levels**		**First Differences**	
ypc	-1.87	-1.71	-3.45***	-3.38***
fd	-1.43	-2.23	-4.87***	-4.69***
ec	-1.56	-1.96	-4.97***	-4.58***
efc	-1.42	-2.43	-3.24***	-4.64***
kof	-1.84	-2.21	-4.77***	-4.91***

Notes: p- values from the respective Tests, Null hypothesis: unit root (non-stationarity).
* p<0.10; ** p<0.05; *** p<0.01

With cross-sectional dependence confirmed and I(1) behaviour established, the third step tests whether long-run slope coefficients are homogeneous across countries. Imposing slope homogeneity in a heterogeneous panel inflates type-I error and produces spurious average effects (Pesaran and Yamagata, 2008). The Pesaran–Yamagata (2008) Δ test and its bias-adjusted version provide the baseline inference; Blomquist and Westerlund (2013, 2016) extend the test to allow for autocorrelation and heteroscedasticity jointly via HAC correction and bootstrap critical values (Bersvendsen and Ditzen, 2021). Rejection of homogeneity motivates mean-group estimation rather than pooled methods.

Table no. 5 presents the results from the Pesaran and Yamagata (2008) and the Blomquist and Westerlund (2013, 2016) tests.

Table no. 5 – Slope homogeneity test results

Methodology	Pesaran -Yamagata				Blomqvist-Westerlund	
type of test	baseline test		Autocorr. Correction		hac Correction	
test statistic	Delta	p value	Delta	p value	Delta	p value
stat.	16.82	0.00	27.01	0.00	4.27	0.00
adj.stat	20.37	0.00	31.19	0.00	12.08	0.00

Note: Null Hypothesis: Homogeneous slope coefficients

Both the Pesaran–Yamagata test and the Blomqvist–Westerlund tests reject the null hypothesis of slope homogeneity, with p-values below 0.05 for all testing methods (baseline, autocorrelation correction, and HAC correction). This suggests that the long-term

relationships between GDP per capita and its determinants vary considerably across countries, reflecting differences in growth dynamics. This finding aligns with the empirical literature that supports heterogeneity in the growth–energy and environment relationship nexus (Stern, 2011) as well as the growth-financial development and financial integration nexus Westerlund (2005); (Ibrahim *et al.*, 2024; Wang *et al.*, 2024).

With all series confirmed as I(1) under dependence and slope heterogeneity established, the fourth step tests for long-run cointegration. We employ two complementary Westerlund procedures. Westerlund (2005) provides a variance-ratio statistic for the null that no panel is cointegrated. Westerlund (2007) generates four statistics: group-mean tests (Gτ, Ga) that allow heterogeneous adjustment speeds and are informative about the fraction of cointegrated units, and panel statistics (Pt, Pa) that pool information and gain power when the null is globally false. Both procedures are implemented with 1,500 bootstrap replications to obtain dependence-robust p-values.

The Westerlund (2005, 2007) cointegration tests presented in Table no. 6 provide strong evidence of a long-term cointegrating relationship between the variables. The null-hypothesis of no cointegration is rejected by the Ga, Pt, and Pa test statistics at a minimum confidence level of 95%, while the Westerlund (2005) test indicates that all panels are cointegrated at the 99% level. These results align with existing literature that identifies long-term equilibrium relationships between economic growth and energy consumption, as well as between economic growth and environmental degradation. The findings suggest that, despite short-term fluctuations, these variables are interconnected in the long run (Narayan and Narayan, 2010).

Table no. 6 – 2nd generation cointegration test results

Westerlund (2007) Bootstrap test for cointegration			
Statistic	Value	Z value	Rob. p value
Gt	-1.307	7.782	0.68
Ga	-0.079	16.422	0.05
Pt	-6.824	9.82	0
Pa	-0.611	8.969	0
Westerlund (2005) test for cointegration			
Alternative Hypothesis	Variance ratio	Statistic	Robust p value
Some panels not cointegrated		4.872	0.00
All panels cointegrated		3.161	0.00

Note: Null Hypothesis: No cointegration, model with constant & 2 lags, 1,500 simulations

With cointegration established, the fifth step estimates long-run elasticities across five heterogeneous panel estimators chosen to span a range of identifying assumptions and dynamic specifications. The Augmented Mean Group (MG-AUG) (Eberhardt and Teal, 2010, 2011) controls for cross-sectional dependence via an estimated common dynamic factor. The Common Correlated Effects Mean Group (CCE-MG) (Pesaran, 2006) proxies unobserved common factors with cross-sectional averages, allowing heterogeneous factor loadings. The CCE-GMM (Neal, 2015a; Neal, 2015b) introduces moment conditions to address potential regressor endogeneity within the CCE framework. Since the standard CCE estimator is consistent only in static specifications (Chudik and Pesaran, 2015b), we complement it with two dynamic variants: the Dynamic CCE Mean Group (DCCE-MG) (Chudik and Pesaran, 2015a) and the cross-sectionally augmented ARDL (CS-ARDL). Consistency of sign and significance across all five estimators – which differ in their treatment of dynamics, endogeneity, and common-

factor structure – constitutes a stringent internal robustness check. Table no. 7 reports the estimates.

Table no. 7 – Long-run estimates

(Dependent Variable *ypc*)

Equation	MG-AUG (long-run)		CCE-MG-OLS		CCE-MG-GMM		DCCE MG-OLS		CS-ARDL	
Variable	**coefficient**	**prob**	**coefficient**	**prob**	**coefficient**	**prob**	**coefficient**	**prob**	**coefficient**	**prob**
$ypc_{i,t-1}$							-0.442***	0.00	-0.459***	
$fd_{i,t-1}$	0.043**	0.02	0.035***	0.03	0.082***	0.03	0.019*	0.07	0.098**	0.04
$ec_{i,t-1}$	0.192***	0.00	0.140***	0.00	0.262***	0.00	0.084***	0.00	0.294***	0.00
$efc_{i,t-1}$	0.240***	0.00	0.154***	0.00	0.171***	0.00	0.165***	0.00	0.459***	0.00
$kofi_{i,t-1}$	0.052***	0.01	0.022*	0.10	0.076***	0.01	0.031***	0.01	0.093*	0.08
constant	6.838***	0.00	0.230	0.65	-0.453	0.43	-0.464945	0.23		

Notes: * p<0.10; ** p<0.05; *** p<0.01, *** significant at 1%

The MG-AUG method introduced by Eberhardt and Teal (2010), accounts for both heterogeneity and cross-sectional dependence across countries by incorporating a common dynamic factor affecting all countries, rather than treating the common factor as a nuisance term as in the CCE-MG approach. This methodology provides insights into the long-term relationships between economic growth and key variables. According to the MG-AUG estimates, the coefficients for financial development and globalization are 0.043 and 0.052, respectively, indicating a significant positive long-term relationship with economic growth. Additionally, energy consumption demonstrates a positive long-term effect with a coefficient of 0.192, while the ecological footprint (EF) has a coefficient of 0.240, indicating that environmental degradation also contributes positively to long-term economic growth.

The CCE-MG estimator (Pesaran, 2006) proxies unobserved common factors with cross-sectional averages of all variables, controlling for global shocks while allowing heterogeneous factor loadings. The CCE-MG long-run estimates are: fd = 0.035, kof = 0.022, ec = 0.140, efc = 0.154 – all positive and significant. Compared to MG-AUG (fd = 0.043; ec = 0.192), the CCE-MG coefficients for finance and energy are smaller, which is expected: MG-AUG absorbs the common factor as an explicit additional regressor, while CCE-MG uses cross-sectional averages; the two estimators apportion common versus idiosyncratic variation differently. Positive signs hold across both specifications (Pesaran, 2006).

The CCE-GMM estimation method (Neal, 2015a) addresses the potential endogeneity of independent variables by employing the generalized method of moments (GMM). This method produces higher coefficient estimates compared to the CCE-MG method. Specifically the long-run parameters are all positive and significant, with financial development having a coefficient of 0.082, financial globalization 0.076, energy consumption 0.262, and the ecological footprint 0.171. These estimates are notably larger than those obtained from the CCE-MG approach, underscoring the stronger influence of these factors on long-term economic growth when endogeneity is accounted for.

The CS-ARDL model (Chudik and Pesaran, 2015a; Ditzen, 2018) builds upon the pooled mean group (PMG) approach (Pesaran *et al.*, 1999) by incorporating cross-sectional averages to account for cross-sectional dependence. This method is particularly effective in capturing long-run equilibrium relationships within heterogeneous, cross-sectionally dependent panel data, while also accommodating dynamic specifications for both the dependent and independent variables. The CS-ARDL method provides the highest long-run coefficient estimates among the models analyzed. The coefficients are 0.098 for financial development, 0.093 for financial globalization, 0.294 for energy consumption, and a

particularly large 0.459 for the ecological footprint. The significant positive coefficient for the ecological footprint underscores its strong and enduring impact on economic growth. This finding aligns with studies suggesting that environmental exploitation can contribute to long-term growth, albeit often in an unsustainable manner (Grossman and Krueger, 1995). The CS-ARDL model's ability to account for the cumulative long-term effects of these factors likely explains why its parameter estimates are larger than those of other methods, providing a comprehensive understanding of their sustained impact on economic growth.

The Dynamic CCE Mean Group (DCCE-MG) estimator incorporates multiple lags of cross-sectional averages to absorb richer common-factor dynamics (Chudik and Pesaran, 2015b; Ditzen, 2018, 2019). As the most demanding specification in terms of factor absorption, it yields the smallest coefficients: fd = 0.019, kof = 0.031, ec = 0.084, efc = 0.165. This reflects the estimator partitioning out more of the global co-movement, leaving the idiosyncratic component – arguably the most relevant for country-level policy inference. All four remain positive and significant.

The long-term estimates indicate that the elasticity values for financial development and financial globalization are lower compared to those for energy consumption and environmental degradation. Interestingly, the relatively similar magnitudes for financial globalization and financial development suggest that policy-based financial openness and domestic financial deepening are comparably important long-run drivers of economic growth. Furthermore, the findings highlight that environmental degradation exerts a greater long-term impact on economic growth than energy consumption, reflecting the broad consumption-based nature of the ecological footprint proxy. These results are grounded in established theoretical channels. The positive finance coefficient is consistent with the savings mobilization and capital allocation role of financial intermediation posited by Levine (1997) and documented empirically by Beck *et al.* (2000). The positive globalization coefficient aligns with the neoclassical prediction that capital flows toward higher-return economies, supplementing domestic savings and lowering the cost of capital (Kose *et al.*, 2006b; Obstfeld, 2021). The positive energy coefficient reflects the energy-as-input view of production advanced by Stern (2011), whereby energy services underpin industrial productivity especially in energy-intensive economies. The positive ecological footprint coefficient reflects a scale effect: historically, higher income has been associated with higher resource consumption, consistent with incomplete decoupling documented across the 1993–2020 period (Grossman and Krueger, 1995; Borucke *et al.*, 2013). Comparing our results to prior literature, the positive finance-growth coefficient (0.019–0.098 across estimators) is consistent with the meta-analytic range reported by Levine (2005) and the cross-country evidence of King and Levine (1993), while the relatively modest magnitudes align with more recent evidence suggesting diminishing returns to finance in already-developed financial systems (Purewal and Haini, 2022). The energy elasticity (0.084–0.294) is broadly consistent with Apergis and Payne (2010), who document a long-run positive relationship across OECD panels, and with Stern (2011), though our global sample yields somewhat lower average magnitudes due to cross-country heterogeneity. The financial globalization coefficient (0.022–0.093) is positive and modest, consistent with the conditional nature of globalization's growth payoff documented by Kose *et al.* (2010), who find that benefits depend on absorptive capacity and institutional quality. The ecological footprint coefficient (0.154–0.459) is larger than typical CO_2 emission coefficients in the literature, partly reflecting the broader resource-demand coverage of the footprint and partly the sample composition, consistent with

footprint-based evidence in Charfeddine and Mrabet (2017). The key additional insight this study provides is that these positive long-run relationships hold robustly across all five complementary estimators, and that explicit causality testing reveals the directions of these linkages rather than merely their existence.

In the sixth step of the analysis, the causal relationships between GDP and the independent variables are examined using the Dumitrescu and Hurlin (2012) noncausality test, following the framework outlined by Lopez and Weber (2017). To address cross-sectional dependence, a block bootstrap procedure, as detailed in Section 6.2 of Dumitrescu and Hurlin (2012), is used to derive the critical values for the test statistics. The results, summarized in Table no. 8, reveal evidence of bidirectionality: strong bidirectional causality for ecological pressure, while financial globalisation, finance, and energy show asymmetric evidence, with one direction significant at conventional levels and the reverse direction marginal at the 10% level. These results indicate that each driver both influences and is influenced by economic growth, though with varying statistical strength. This finding indicates that these factors not only drive long-term GDP growth but are also influenced by economic growth, underscoring the dynamic interplay between growth and its key determinants.

Table no. 8 – Dumitrescu–Hurlin test results

Null Hypothesis:	W-bar	Z-bar	Z-bar tilde	Prob.
fd does not homogeneously cause *ypc*	2.966	16.572	13.511	0.06
ypc does not homogeneously cause *fd*	3.920	24.606	20.378	0.00
ec does not homogeneously cause *ypc*	2.672	14.090	11.389	0.08
ypc does not homogeneously cause *ec*	4.043	25.637	21.259	0.02
efc does not homogeneously cause *ypc*	2.550	13.060	10.509	0.02
ypc does not homogeneously cause *efc*	5.004	33.737	28.184	0.00
kof does not homogeneously cause *ypc*	2.861	15.681	12.749	0.00
ypc does not homogeneously cause *kof*	2.617	13.627	10.993	0.06

Note: bootstrap probabilities after 800 simulations

The causality evidence warrants careful interpretation given the significance levels. For financial development and GDP (p = 0.06 and 0.00 respectively), there is strong evidence that growth drives financial development, and weaker evidence (10% level) of the reverse direction. For energy, growth significantly drives energy demand (p = 0.02), while the energy→GDP direction is marginal (p = 0.08). Together these suggest a feedback dynamic between income and both finance and energy, consistent with the supply-side and demand-side channels discussed in Section 2 (Levine, 2005; Stern, 2011), though not all directions are significant at the conventional 5% threshold.

Ecological pressure and GDP show robust bidirectional causality at the 1–5% level: higher income is associated with greater ecological footprint (consistent with scale effects and incomplete decoupling), while footprint also Granger-causes income, possibly through resource-use channels that sustain production (Grossman and Krueger, 1995). Financial globalisation shows the clearest bidirectionality: kof→ypc is significant at the 1% level (p = 0.00) and ypc→kof is marginal at 10% (p = 0.06), consistent with the view that growing economies attract greater international financial integration (Kose *et al.*, 2006a; Prasad *et al.*, 2007). Taken together, the causality evidence supports an interpretation of mutual

reinforcement between income and its four structural drivers, with the strength and direction varying by variable.

To complement the long-run mean elasticities with distributional evidence, we estimate the long-run relationship across income deciles using the Method of Moments Quantile Regression (MMQR) approach of Machado and Santos Silva (2019). Unlike standard quantile regression, MMQR uses moment conditions that model heteroscedasticity through covariates, enabling conditional quantile estimation without distributional assumptions (Aziz *et al.*, 2021). To address cross-sectional dependence, variables are demeaned following Sarafidis *et al.* (2009). The MMQR estimates are presented in Table no. 9, with quantile coefficient plots in Figure no. 1.

Table no. 9 – Estimated quantile parameters

Panel Quantile Method of Moments (MMQR) Estimates

Variables	Location	Scale	0.1	0.2	0.3	0.4
fd	0.152***	-0.003	0.158***	0.15***	0.154***	0.153***
eci	0.239***	0.004	0.231***	0.235***	0.236***	0.238***
efc	0.277***	-0.050	0.354***	0.324***	0.304***	0.292***
kof	0.111***	-0.020	0.141***	0.129***	0.121***	0.116***
const	-6.362***	0.393	-6.970***	-6.729***	-6.573***	-6.473***

Variables	0.5	0.6	0.7	0.8	0.9
fd	0.152***	0.152***	0.150***	0.149***	0.147***
eci	0.238***	0.240***	0.241***	0.243***	0.246***
efc	0.278***	0.266***	0.250***	0.231***	0.197***
kof	0.110***	0.106***	0.100***	0.092***	0.078***
const	-6.371***	-6.273***	-6.148***	-5.998***	-5.729***

Notes: * p<0.10; ** p<0.05; *** p<0.01, *** significant at 1%

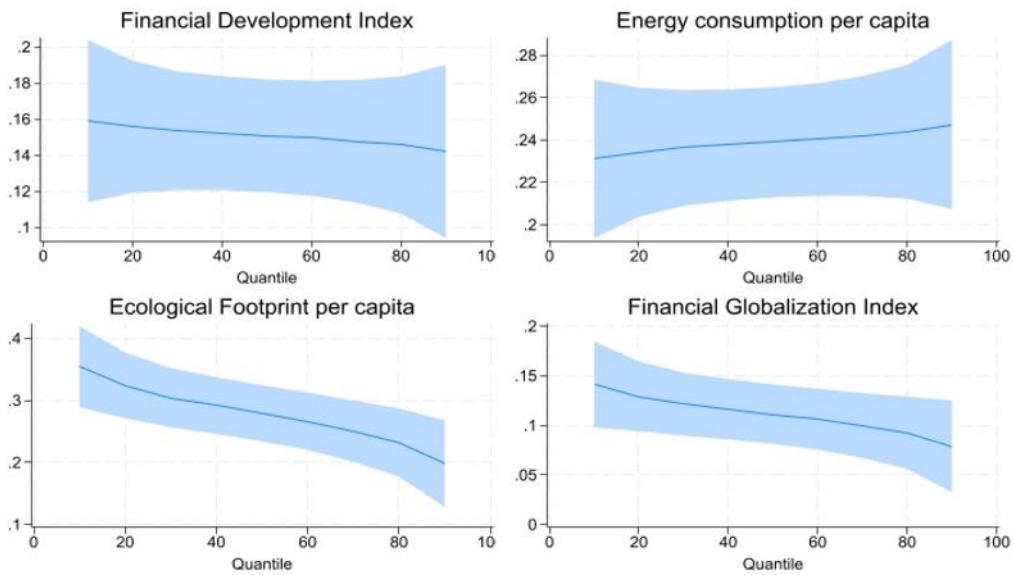

Figure no. 1 – Quantile coefficient graphs

The long-run elasticity estimates across different deciles (ranging from 0.1 to 0.9) reveal how the impacts of various factors differ across the GDP distribution. Financial development consistently demonstrates a positive and significant effect on GDP per capita across all deciles, with coefficients ranging from 0.158 at the lower deciles to 0.147 at the upper decile. This suggests that financial development promotes economic growth, particularly in lower- and middle-income economies, which aligns with previous empirical findings (Nguyen, 2023). The effect appears to diminish in higher-income countries. Likewise, financial globalization demonstrates a positive and significant impact on GDP per capita, but its effect decreases across quantiles – from 0.141 at the 0.1 decile to 0.078 at the 0.9 decile. This implies that financial globalization has a greater impact on lower-income countries, facilitating capital flows and access to international financial markets. However, in higher-income countries, domestic factors may play a more prominent role, reducing the relative importance of financial globalization.

Energy consumption per capita also exhibits a positive and significant impact on GDP across all deciles, with coefficients rising from 0.231 at the first decile to 0.246 at the highest decile. This underscores the critical role of energy consumption in driving economic growth, supporting the literature on the essential role of energy in powering industries and services. Notably, the increasing effect across income levels highlights energy's persistent and growing contribution to economic performance at various stages of development.

The ecological footprint per capita shows a significant yet diminishing impact on GDP across quantiles, with coefficients declining from 0.354 at the 0.1 decile to 0.197 at the 0.9 decile. This pattern suggests that while environmental degradation may contribute to economic growth in lower-income countries, its influence weakens as income levels rise. These findings align with the trade-offs between environmental degradation and economic growth, particularly in resource-intensive economies. However, the results also underscore the increasing awareness and prioritization of environmental costs as economies progress and develop.

Overall, the findings indicate that financial development, energy consumption, and financial globalization are critical drivers of economic growth across all income levels. Nevertheless, the ecological footprint has a positive impact in lower-income countries but becomes less beneficial as countries reach higher income levels, reflecting the increasing awareness of environmental sustainability. These results align with broader literature acknowledging the complex relationship between environmental sustainability and economic growth as economies evolve.

5. CONCLUSIONS AND POLICY IMPLICATIONS

This paper has examined the joint long-run determinants of real income per capita across 142 economies over 1993–2020, providing four distinct contributions: a unified framework for four drivers rarely modelled together, five complementary estimators as an internal robustness strategy, the ecological footprint as a consumption-based environmental proxy, and explicit panel causality evidence via the Dumitrescu–Hurlin test. Three substantive findings emerge consistently across all estimators. First, energy use and ecological pressure are the largest and most robustly estimated long-run correlates of income, reflecting the energy and resource intensity of historical development paths. Second, financial globalisation is positively and consistently associated with long-run income, with the effect stronger in lower-income quantiles. Third, financial development is positive across specifications but

more sensitive to proxy measurement and to common-factor absorption, consistent with recent evidence on diminishing returns and proxy sensitivity in the finance–growth literature.

Across the five estimators, financial development and financial globalisation remain positively associated with long-run income, but their elasticities are smaller than those for energy use and ecological pressure. This pattern suggests that finance and openness operate more as enabling conditions for growth than as stand-alone engines of long-run income expansion. The positive finance coefficient is consistent with the savings mobilisation and capital-allocation channel emphasised in the finance–growth literature (Levine, 1997; Beck *et al.*, 2000), while the positive financial-globalisation coefficient is consistent with the view that cross-border capital integration can supplement domestic savings and ease financing constraints, conditional on institutional and macroeconomic capacity (Kose *et al.*, 2006b; Obstfeld, 2021).

The ecological footprint remains positively associated with income across all estimators, reflecting the energy and resource intensity of observed development paths over 1993–2020. The MMQR results show that this positive association weakens at higher income quantiles – the coefficient declines from 0.354 at the 10th percentile to 0.197 at the 90th – consistent with partial decoupling as countries become richer, but not with reversal: ecological pressure does not become detrimental in the estimated quantiles. Finance and financial globalisation also display stronger conditional associations at lower quantiles, indicating that their marginal growth payoffs are larger where intermediation and integration constraints are more binding (Obstfeld, 2020).

Two limitations should be kept in view. First, although the Dumitrescu–Hurlin results provide useful directional evidence, they should be interpreted as Granger-causal rather than as evidence of structural causal identification. Second, the use of composite indices for financial development and financial globalisation improves conceptual coverage but also makes the results sensitive to index construction. Future research could examine subgroup heterogeneity across development stages, alternative environmental proxies such as material footprint or CO_2-based measures, and richer distributional frameworks that combine multifactor long-run controls with quantile inference.

Financial globalisation is positively associated with long-run income in our estimates, but the evidence also underscores that its payoff is conditional on regulatory quality, supervisory capacity, and macroprudential resilience. Reforms that increase the quality of integration – transparent regulatory frameworks, resilient financial supervision, and instruments that limit excessive risk-taking – matter as much as the level of integration itself. Gradual capital account liberalisation, paired with adequate macroprudential safeguards, can allow developing economies to access global capital without amplifying vulnerability to sudden stops. For sustainable globalisation strategies, policymakers should encourage foreign direct investment in renewable energy, green infrastructure, and low-emission technologies. Integrating environmental standards into trade agreements and FDI frameworks can better align global capital flows with environmental objectives, and cross-border climate finance collaborations can channel international capital toward sustainable investment.

The availability of energy is crucial for driving economic growth and enhancing productivity across industries, transportation, and households. However, to ensure sustainability, policymakers must prioritize energy efficiency by encouraging investments in energy-saving technologies and infrastructure that lower overall energy consumption without hindering economic progress. Expanding the use of renewable energy sources such as solar,

wind, and hydropower is another essential approach to diversifying energy systems, reducing dependence on fossil fuels, and minimizing environmental impacts. Governments can further support this transition by implementing favourable policies, including green bonds, subsidies, and feed-in tariffs, to attract private investment in renewable energy projects. Scaling up clean energy production not only reduces environmental footprints but also creates employment opportunities and stimulates economic activity. Additionally, carbon pricing mechanisms, such as carbon taxes or emissions trading systems, should be introduced to internalize the environmental costs of energy use, incentivizing businesses to lower their carbon emissions. Investing in local energy production and storage technologies can enhance energy security by ensuring stable supply chains amidst fluctuating global energy prices. By integrating these sustainability-focused measures into energy policies, countries can achieve economic growth while preserving environmental health, reducing carbon emissions, and mitigating long-term environmental degradation.

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ANNEX

List of countries

Albania, Algeria, Angola, Argentina, Armenia, Australia, Austria, Azerbaijan, The Bahamas, Bangladesh, Barbados, Belarus, Belgium, Belize, Benin, Bhutan, Bolivia, Bosnia and Herzegovina, Botswana, Brazil, Brunei Darussalam, Bulgaria, Burkina Faso, Burundi, Cabo Verde, Cambodia, Cameroon, Canada, Chad, Chile, China, Colombia, Congo, Dem. Rep., Congo, Rep., Costa Rica, Côte d'Ivoire, Croatia, Cyprus, Czechia, Denmark, Dominican Republic, Ecuador, Egypt, Arab Rep., El Salvador, Estonia, Eswatini, Ethiopia, Fiji, Finland, France, Gabon, Georgia, Germany, Ghana, Greece, Grenada, Guatemala, Guinea, Guyana, Honduras, Hungary, India, Indonesia, Iran, Islamic Rep., Ireland, Israel, Italy, Jamaica, Japan, Jordan, Kazakhstan, Kenya, Korea, Rep., Kuwait, Kyrgyz Republic, Lao PDR, Latvia, Lebanon, Lesotho, Lithuania, Luxembourg, Madagascar, Malawi, Malaysia, Mali, Malta, Mauritania, Mauritius, Mexico, Moldova, Mongolia, Morocco, Mozambique, Namibia, Nepal, Netherlands, New Zealand, Nicaragua, Niger, Nigeria, North Macedonia, Norway, Oman, Pakistan, Panama, Papua New Guinea, Paraguay, Peru, Philippines, Poland, Portugal, Romania, Russian Federation, Rwanda, Saudi Arabia, Senegal, Sierra Leone, Singapore, Slovak Republic, Slovenia, South Africa, Spain, Sri Lanka, St. Lucia, Suriname, Sweden, Switzerland, Tanzania, Thailand, Togo, Tunisia, Türkiye, Uganda, Ukraine, United Arab Emirates, United Kingdom, United States, Uruguay, Uzbekistan, Vietnam, Yemen, Rep., Zambia.