

Carbon Pricing, Green Investment and Job Quality in Eight Leading Energy-Transitioning Economies: Implications for Employment, Health and the Sustainable Development Goals (SDGs)

Ceny emisji dwutlenku węgla, zielone inwestycje i jakość pracy w ośmiu wiodących globalnych gospodarkach przechodzących transformację energetyczną: implikacje dla zatrudnienia, zdrowia i Celów zrównoważonego rozwoju (SDGs)

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Abstract

Addressing climate change and improving population welfare remain central pillars of the global sustainability agenda. Motivated by Sustainable Development Goals (SDGs) 3 (Good Health), 7 (Affordable and Clean Energy), 8 (Decent Work and Economic Growth), and 13 (Climate Action), this study examines how carbon pricing, green investment, and job quality influence employment and community health across eight leading energy-transitioning economies, Brazil, China, France, Germany, India, Japan, Spain, and the United States. Using panel data from 2013–2023, covering the pre-COVID period (2013–2019) and the COVID-period (2020–2023), we apply multiple estimators (PCSE, FGLS, fractional probit, pooled regression, and two-way fixed effects). Findings show that while carbon pricing and green investment are essential for long-term decarbonization, they exert short-run labour-market pressures, with carbon pricing significantly reducing employment in both periods. Green investment also shows a negative short-term effect on employment, reflecting early-stage capital intensity of renewable energy transitions. Job quality has limited effects on employment but significantly improves life expectancy, underscoring its importance for SDG 3. Carbon pricing positively influences life expectancy, confirming key health co-benefits of climate policy. Results emphasize the need for inclusive green-transition policies, especially labour-market protections and reskilling systems that ensure climate action aligns effectively with SDGs 3, 7, 8, and 13.

Key words: carbon pricing, employment, green investment, job quality, SDGs, energy transition

Streszczenie

Przeciwdziałanie zmianom klimatu i poprawa dobrobytu ludności pozostają centralnymi filarami globalnego programu zrównoważonego rozwoju. Kierując się Celami Zrównoważonego Rozwoju (SDGs) nr 3 (Dobre zdrowie), 7 (Przystępna i czysta energia), 8 (Godna praca i wzrost gospodarczy) i 13 (Działania na rzecz klimatu), w artykule

przeanalizowano wpływ cen emisji dwutlenku węgla, zielonych inwestycji i jakości pracy na zatrudnienie i zdrowie społeczności w ośmiu wiodących globalnych gospodarkach transformujących się energetycznie: Brazylii, Chinach, Francji, Niemczech, Indiach, Japonii, Hiszpanii i Stanach Zjednoczonych. Wykorzystując dane panelowe z lat 2013–2023, obejmujące okres przed pandemią COVID-19 (2013–2019) i okres pandemii COVID-19 (2020–2023), zastosowaliśmy wiele estymatorów (PCSE, FGLS, ułamkowy model probitowy, regresja zbiorcza i dwukierunkowe efekty stałe). Wyniki pokazują, że chociaż ustalanie cen emisji dwutlenku węgla i zielone inwestycje są niezbędne dla długoterminowej dekarbonizacji, wywierają one krótkoterminową presję na rynek pracy, a ustalanie cen emisji dwutlenku węgla znacząco ogranicza zatrudnienie w obu okresach. Zielone inwestycje wykazują również negatywny krótkoterminowy wpływ na zatrudnienie, odzwierciedlając wczesną fazę inwestycji w energię odnawialną. Jakość pracy ma ograniczony wpływ na zatrudnienie, ale znacząco poprawia oczekiwaną długość życia, co podkreśla jej znaczenie dla SDG 3. Ustalanie cen emisji dwutlenku węgla pozytywnie wpływa na oczekiwaną długość życia, potwierdzając kluczowe korzyści zdrowotne polityki klimatycznej. Wyniki podkreślają potrzebę inkluzywnych polityk zielonej transformacji, zwłaszcza w zakresie ochrony rynku pracy i systemów przekwalifikowania zawodowego, które zapewnią skuteczną zgodność działań na rzecz klimatu z SDG 3, 7, 8 i 13.

Słowa kluczowe: ceny emisji dwutlenku węgla, zatrudnienie, zielone inwestycje, jakość pracy, Cele Zrównoważonego Rozwoju, transformacja energetyczna

1. Introduction

Amid mounting carbon emissions and global warming, many countries across the globe design and implement policies to speed up their energy transition process (Amin et al., 2025; Degbedji et al., 2024; Du et al., 2025). Cardinal objectives of the transition remain the mitigation of climate change, improving energy security and decarbonizing energy sectors. Carbon pricing is, so far, the most common policy implemented to decarbonize energy sectors and, combat climate change.

As a market-based policy instrument, the pricing serves as a strategy of internalizing the external costs of carbon emission, thereby compelling the emitter bear the social cost of the emissions (Koh et al., 2021; Imandojemu et al., 2026a; Imandojemu et al., 2026b; Telaye et al., 2019; World Bank, 2023), the carbon pricing encourages cleaner production and consumption patterns. Carbon tax and emission trading systems (ETS) are the two carbon pricing tools, the former is a direct tax on the carbon content of fossil fuels, which is imposed as a fixed rate per ton of carbon emitted. The Emissions trading systems or cap-and-trade is a tool used by government to set a cap on total emissions and issues tradable permits (Hafstead, 2019). The rationale for carbon pricing is its ability to deal with the *negative externality* of carbon emissions, because indirect costs of the emissions (such as the climate- and health-related impacts) are not reflected in market prices for goods and services, leading to over production. Another policy commitment is the green investment policy that large number of countries have adopted over the years. The investment includes both financial and technical commitment of resources toward promoting decarbonisation and preserving or improving the natural assets. The investments are largely channeled into climate-friendly projects including solar farms, wind power, and clean transport systems. In 2023, Renewable Energy Policy Network for the 21st Century (REN21) (2024) reports that global investment in renewable power and fuels has reached a record high of US\$622.5 billion. These increases mainly arise from the strategic integration of climate action, energy security, and industrial policy, shaped by the dual pressures of the global energy crisis and the post-pandemic economic recovery (REN21, 2024).

While countries are transitioning to renewables, there is also an increasing call for improvement in job quality across the globe. When job quality improves, it increases productivity and raises living standards, thereby creating a powerful pathway toward sustainable growth and poverty reduction (Hovhannisyan et al., 2022; Imandojemu et al., 2026c). An improvement in job quality is central to the energy transition process; it determines the transition's speed and equity. The transition can inevitably lead to *creative destruction* in the carbon-intensive sectors, and public assistance and unrest are abounded if the new jobs created in renewable energy are low-paid, unsafe, insecure and indecent.

The energy transition inherently generates *creative destruction*, phasing out jobs in carbon-intensive industries. If the new jobs created in renewable energy, energy efficiency, and circular economy sectors are precarious, low-paid, or unsafe, it will fuel significant public resistance and social unrest. Ensuring that green jobs offer fair wages, security, and safe working conditions is therefore essential to building and maintaining a broad social consensus for ambitious climate action (International Labor Organization (ILO), 2015). For a just energy transition, many countries have undertaken such programmes as upskilling and reskilling, social protection for displaced workers, and strong labour standards in emerging green industries

Motivated by the objectives of energy transition policies and their alignment with Sustainable Development Goals (SDGs) 8 (Decent Work and Economic Growth), 7 (Affordable and Clean Energy) and 13 (Climate Action), this study sets out to examine the distributional effects of carbon pricing, green investments and job quality on overall employment and community health, represented by life expectancy. The study focuses on eight world leading

transition economies across the globe: Brazil, China, France, Germany, India, Japan, Spain and the US. Focusing on these countries will provide fresh insights as to whether or the transition is just in terms of creation of jobs or improvement in community health.

The study further contributes to the body of knowledge whether the COVID-19 pandemic that shutdown the global economy has weakened or strengthened the effects of these factors on employment and life expectancy among these countries.

The focus of this study is grounded in global sustainability commitments. Each variable examined aligns with specific Sustainable Development Goals (SDGs): carbon pricing with SDG 13 (Climate Action), green investment with SDG 7 (Clean Energy) and SDG 9 (Industry & Innovation), job quality and employment with SDG 8 (Decent Work), and life expectancy with SDG 3 (Good Health). Integrating these SDGs provides a multidimensional sustainability lens consistent with the journal's mandate and strengthens the study's contribution to ongoing global energy-transition dialogues.

Following the introduction, the remainder of the paper is structured as follows: section reviews relevant theories and empirical studies whereas section 3 presents the methodology of the study, particularly the sources of data, measurement variables, model specifications and estimation techniques. Section 4 interprets the results from the estimations and discusses the findings, while section 5 concludes the study with the key findings and policy implications.

2. Literature review

This section engages in thematic literature on how carbon pricing, green investment and job quality affect employment and life expectancy.

2.1. Energy transition policies and labor market outcome

Schumpeterian creative destruction theory provides theoretical mechanism through which green investment and carbon pricing can influence labor market outcome particularly employment. In the creative destruction theory, economic development is observed to bring about economic changes, specifically dismantling some existing industries, jobs and technologies while creating new ones (Schumpeter, 1934). The net effect can be positive if creation outweighs the destruction, or negative if otherwise. Green investments and carbon pricing are the instruments that can be used to destroy carbon-intensive sectors while promoting renewable energy sectors. Osabohien et al. (2025b) link clean energy to post-COVID growth and climate outcomes, Osakede et al. (2024) show renewable energy improves human development in Africa, Sahan et al. (2025) highlight green HRM's role in environmental performance, Wei et al. (2025) find clean cooking reduces climate risks, and Zheng et al. (2023) emphasize energy and business activity in driving sustainable development. Osabohien et al. (2026) show that renewable energy adoption and carbon footprint reduction significantly enhance environmental management by improving sustainability outcomes and supporting the transition toward low-carbon development.

In the short-run, the destruction could outweigh the creation leading to negative effects of the tools on employment. Given the huge need for up-front investments in infrastructure, generation of green supply chains and re-skilling, job creation in renewable sectors could be slow. Arthur Pigou (1920) externality theory further supports the negative effects of carbon pricing on employment, by raising production costs, leading to reduction in demand for labor. Following Becker (1964) human capital theory, job quality can increase employment in the long run, high pay, job security, safety and skill development are considered as human capital investments that raise individuals' employability. This study argues that high job quality can reduce employment in the short run as the individuals require time to develop the skills for the new jobs.

From empirical ground, Aguilar, González and Hurtado (2022), using computation general equilibrium, explore how carbon pricing affect employment in Spain. The study establishes that a rise in the price of emission allowances from about €25 per ton of CO₂ in 2019 to almost €100 per ton in 2022 causes 0.37% reduction in employment or GDP. The severity of the reduction depends on the energy intensity of an industry. Similarly, Wei and Yip (2025), using a difference-in-differences approach, find that the carbon tax lowers the average hourly wage rate by 2.5% and raises the unemployment rate by 1.3% points in British Columbia. Supporting these findings, Yoshino, Rasoulinezhad and Taghizadeh-Hesary (2021) explored how carbon tax can affect the macroeconomy in Japan using the structural vector autoregression (S-VAR) technique based on quarterly data for the period 2005–2020. The study observed that energy price rise induced by carbon tax triggers reduction in real GDP or employment in the economy. On the contrary, Cao (2023) observed that the ETS policy does not have any significant impact on the unemployment rate across the 33 countries that implemented carbon pricing between 1995 and 2021. In terms of green investments, Zhang et al. (2023), using Quantile Autoregressive Distribution Lag based Chinese data for the period 1995–2020, found that clean energy investments have a negative impact on employment across both short and long run. Conversely, Ibrahiem and Sameh (2020) found, based vector error correction results, that clean energy resources reduce unemployment in Egypt. In same vein, Cui et al. (2022) established that green finance has significantly curtailed the unemployment rate among 30 Chinese provinces. Fabra et al. (202) in Spain

and Souza et al. (2024) in Ecuador, supported the major finding that green investment increase employment. Based on analysis of Swedish employees, Berglund, Furåker and Vulkan (2014) discovered that job insecurity directly leads to unemployment. Based on systematic literature review, Buchele and Christiansen (2019) observed mixed findings on the effect of job quality on employment in Europe and the US.

It is clear that majority of the studies observed that carbon pricing reduces employment through increment in production costs that lower demand for labor while other studies prove that green investments raise employment through multiplier effects. Some studies found mixed findings that job quality can increase or decrease employment depending on the context and stage of development of a country.

2.2. Energy transition policies and community health

Grossman (1972) health capital model serves as the theoretical underpinning explaining how carbon pricing, green investments and job quality affect community health in the energy transition economies. Grossman (1972) considers health as a durable form of capital that produces *healthy time* as its output. The model assumes that individuals start life with an initial stock of health, which naturally declines with age beyond a certain stage of the life cycle. However, this health stock can be improved or maintained through deliberate investment and policies. In the context of this study, we posit that carbon pricing, green investment and job quality can be viewed as tools for augmenting the population health.

The imposition of carbon taxes or emissions trading can reduce pollution and greenhouse gas emissions, leading to improved air quality and reduced the incidence of respiratory and cardiovascular diseases. This environmental improvement raises the population's health stock. Investment in clean energy, clean infrastructure, and sustainable technologies create healthier living and working environments by ensuring access to cleaner energy and lowering exposure to environmental hazards. These outcomes lead to improvement in the community health capital. Finally, job quality, represented by decent wages, job security, workplace safety, greenish of the job and protection of labor rights, directly improves individuals' capacity to invest in their health. Higher-quality jobs augment income stability, lower job stress, and enable better access to healthcare and nutritious food.

Empirical view seems to be uniform in their findings that these tools improve community health. Using a dynamic recursive computable general equilibrium (CGE) model, Chen and Wang (2022), for instance, examined the health benefits of climate policies in China. The study found that both carbon tax and emission trading scheme (ETS) curtailed morbidity and mortality in the country, with carbon tax having more health benefits in short term, while health benefits of ETS policy gradually increase in long term. Also using a CGE model for Chinese data, Chen and Li (2024) supported the finding of Chen and Wang (2022) that emission trading scheme enhanced the life expectancy of people in the country. Similarly, many studies across globe found that green investments increase life expectancy while reducing morbidities and mortalities (Byaro & Rwezaula, 2025 in Sub-Saharan Africa; Majeed, Luni & Zaka, 2021 focusing 155 countries; Shaari et al. 2024 in ASEAN countries).

For job quality, Voßemer et al. (2018), their analysis of 89,000 individuals in Europe using random intercept models, observed that job insecurity negatively impacts individuals' health. Likewise Henseke (2018) and Otterbach and Sousa-Poza (2016) found that job quality improves individuals' health in Germany and Europe in general respectively. From the review of empirical studies on health benefits of climate policies and job quality, a consensus has emerged that carbon pricing, green investments and job quality chiefly enhance community health by either raising population life expectancy or reducing the morbidity and mortality across the society.

2.3. Digital transformation, governance and emerging drivers of sustainable energy transition

Recent studies highlight the growing importance of digitalization, advanced methodologies, and governance frameworks in shaping sustainability outcomes and energy transition dynamics. Luo et al. (2023) develop a deep neural network-based assistive decision method for financial risk prediction in carbon trading markets, emphasizing the role of artificial intelligence in improving the efficiency of carbon pricing systems. Ma and Bennett (2024) demonstrate that perceived employability is influenced by both sufficiency and necessity conditions, suggesting that labour-market outcomes depend on multiple interacting factors. Jaaffar et al. (2024) show governance experience drives green practices. Luan et al. (2025) find clean energy and industrialization enhance sustainability. Mohamed et al. (2024) confirm renewable energy reduces emissions, supporting the EKC. Osabohien et al. (2025b) highlight clean energy, policy, and energy justice as key drivers of sustainable development.

Yang et al. (2024) propose a functional-coefficient quantile regression model for panel data with latent group structures, providing a robust econometric framework for capturing heterogeneous effects across economies. Ji et al. (2026) show that technological, organizational, environmental, and human factors jointly determine the adoption of autonomous driving in new energy vehicles, highlighting the complexity of innovation diffusion in green sectors. Gao et al. (2024) examine tourism spatiotemporal behavior using big data and remote sensing techniques, illustrating the relevance of digital tools in sustainable infrastructure planning.

Tian et al. (2026) analyze the complex dynamics of a quantum Stackelberg duopoly model, offering insights into strategic decision-making under uncertainty in economic systems. Hu et al. (2026) find that green finance development strengthens urban green technology transfer networks, reinforcing the importance of financial systems in promoting sustainable innovation. Wu et al. (2025) reveal that shareholder activism leads to shifts in firms' innovation focus, which may influence restructuring and employment patterns during sustainability transitions. Jin et al. (2025) provide evidence that optimal expenditure decentralization promotes sustainable development, highlighting the role of fiscal governance in environmental outcomes.

Huo (2025) introduces a finite-difference solution approach in least-squares Monte Carlo, improving computational efficiency in financial modelling relevant to sustainability investments.

Xia et al. (2025) develop a graph convolutional neural network-based approach to predict trends in digital financial inclusion, underscoring the role of digitalization in inclusive growth. Jiang and Yuan (2026) show that digital currency pilots significantly boost consumption upgrading, indicating the transformative potential of digital financial systems.

Gao et al. (2026) demonstrate that digital transformation enhances value co-creation in manufacturing enterprises, suggesting a shift toward knowledge-intensive production structures. Hu et al. (2026) find that supply chain digitalization promotes technological innovation in new energy vehicle firms, with implications for productivity and labour demand. Abd Majid et al. (2025) show that national gender policy strengthens women directors' empowerment and carbon emissions disclosure practices in global energy companies, highlighting governance influences on environmental transparency. Adeleye et al. (2021) find that energy consumption significantly drives carbon emissions in African countries, reinforcing the urgency of transitioning to cleaner energy systems.

3. Data and methodology

3.1. Theoretical underpinnings and empirical model

For employment model, the study adopts the combination of Schumpeterian creative destruction, Pigovian externality and Becker's human capital theory to underpin how carbon pricing, green investments and job quality influence employment among leading energy transition economies. While creative destruction shows that the transition, supported by carbon pricing and green investment destroys jobs in carbon-intensive sectors while creating new ones in renewable energy sectors. Pigovian externality theory posits carbon tax and emission trading system lead to increase in production costs, thereby lower employment. Human capital theory shows that job quality can increase employment in the long run through reskilling. Equation (1) specifies the employment model:

$$EMP_{it} = \beta_0 + \beta_1 CBP_{it} + \beta_2 GRI_{it} + \beta_3 JBQ_{it} + \beta_m CONV_{it} + \mu_{it} \quad (1)$$

Where t denotes the time (year), i represents cross-sectional unit (country) and μ_{it} stand for an error term in the equation. The dependent variable, EMP_{it} signifies employment; CBP_{it} stands for carbon pricing; GJQ_{it} is the green job quality index. GRI_{it} refers to green investment; CON_{it} is a vector of control variables (real GDP per capita, foreign direct investments, mean years of schooling and labor force participation).

In terms of community health model, the study is underpinned within Grossman's health production model. The contextualized health production model considers green investments, carbon pricing and job quality as investments in health capital that can improve community health. Equation (2) specifies the employment model:

$$LFE_{it} = \delta_0 + \delta_1 CBP_{it} + \delta_2 GRI_{it} + \delta_3 JBQ_{it} + \delta_m CONV_{it} + \varepsilon_{it} \quad (2)$$

Where ε_{it} refers to an error term in equation (2). The dependent variable, LFE_{it} signifies life expectancy at birth, serving as a proxy for community health. CON_{it} is a vector of control variables (real GDP per capita, mean years of schooling and current health expenditure per capita).

3.2. Data, measurements and estimation techniques

This study explores a panel of 8 world-leading energy transition economies: Brazil, China, France, Germany, India, Japan, Spain and the US, using data from International Renewable Energy Agency (IRENA), World Development Indicators (WDI), World Bank's Carbon Pricing Dashboard (CBPD), database of United Nations Development Program (UNDP) and database for the Sustainable Development Report (SDR) compiled and constructed by Sachs, Lafortune and Fuller (2024). And the dataset covers the period from 2013 to 2023. The country sample was determined by the prevalence of green employment and data availability for 2013–2023. This period was strategically divided into a pre-COVID period (2013–2019) and a COVID-period (2020–2023), following the official WHO categorization of the pandemic timeline. The study therefore does not refer to 2020–2023 as post-COVID, but rather as the period during which COVID-19 disruptions remained active.

To empirically investigate the impacts of climate policies and job quality on employment and life expectancy, a multi-method econometric approach was employed. With respect to the employment model, the study engages fractional probit regression (FPR) with clustering, panel corrected standard errors (PCSE) and feasible generalized least squares (FGLS) to analyse the full-sample model while FPR with clustering and two-way fixed effect (2WFE) are used to estimate pre and post-COVID sub-sample models. For the life expectancy model, while the study uses

PCSE, FGLS and pooled regression (POR) estimators to analyse the full-sample model; PCSE and POR are deployed to analyse pre and post-COVID sub-sample models. The essence of engaging multiple econometric techniques to analyse the same models is for the estimators to robust-check one another.

Table 1. Variables, Measurement and SDG Linkages, source: World Bank's WDI and CBPD, SDR, UNDP, ILO and HFE

Variable	Measurement	Source	Related SDG(s)
Employment to population	Working-age population (15+) that is employed as a percentage of total population	WDI	SDG 8 – Decent Work and Economic Growth
Life Expectancy at birth	Average number of years a newborn is expected to live	WDI	SDG 3 – Good Health and Well-being
Carbon Pricing (ETS)	Carbon tax / ETS price (€ per ton of CO ₂)	CBPD	SDG 13 – Climate Action
Job Quality	PCA-based index ¹ (wages, labor rights, safety, green job penetration)	IRENA, SDR, ILO, HFE	SDG 8 – Decent Work and Economic Growth
Green Investment	Renewable electricity output (% of total electricity output)	WDI	SDG 7 – Affordable and Clean Energy; SDG 9 – Industry, Innovation and Infrastructure
Labor Force Participation	Share of working-age population in labor force	WDI	SDG 8 – Decent Work and Economic Growth
Foreign Direct Investment (FDI)	Net inflows (% of GDP)	WDI	SDG 8; SDG 17 – Partnerships for the Goals
Current Health Expenditure (per capita)	Health expenditure per person (US\$)	WDI	SDG 3 – Good Health and Well-being
Mean Years of Schooling	Average years of education (age 25+)	UNDP	SDG 4 – Quality Education
Real GDP per capita	GDP per capita (constant US\$)	WDI	SDG 8 – Decent Work and Economic Growth

Beck and Katz (1995) PCSE method is specifically suited for panel datasets where the number of time periods exceeds the number of cross-sectional units ($T > N$), which aligns with the structure of our sample involving 8 countries tracked annually over 10 years. The PCSE estimator is valuable because it corrects for three common econometric problems in cross-country and policy analyses: unequal error variances across units (panel heteroscedasticity), correlation of errors across countries within the same period (contemporaneous correlation), and serial correlation of errors over time (autocorrelation).

The dependent variable, employment, is a rate bounded between 0 and 1, making FPR an appropriate choice as it clearly models this bounded interval, unlike linear models that can produce predictions outside the intervals (Papke & Wooldridge, 1996). Clustering of standard errors resolves for the possible intra-country correlation in panel data, avoiding underestimated standard errors. FGLS complements PCSE and FPR by also efficiently managing heteroskedasticity and serial correlation across panels, producing more efficient coefficients than standard OLS (Wooldridge, 2010). For the sub-sample analysis, the Two-Way Fixed Effects (2WFE) model is deployed to control for all time-invariant country-specific unobservables and common time shocks, thereby separating the within-country effect of the policies over time (Baltagi, 2008).

For the life expectancy Model, the use of PCSE is justified by the possibility of persistent presence of cross-sectional dependence among the eight major economies, whose health outcomes might have influenced by common global trends and shocks. FGLS is again employed for its efficiency gains in the presence of heteroskedasticity. The inclusion of Pooled Regression (POR) provides a baseline estimate and is useful for capturing the influence of both between-country and within-country variation that are meaningful for policy-level inferences. The application of PCSE and POR across pre- and post-COVID sub-samples enables the study to observe whether the structural relationships determining life expectancy were stable or were fundamentally altered by the pandemic. Table 1 links the core variables of this study to specific Sustainable Development Goals (SDGs) to demonstrate the sustainability relevance of our analytical framework. Carbon pricing aligns with SDG 13 (Climate Action), particularly Target 13.2, as it represents a key climate-policy instrument that integrates decarbonisation measures into national economic systems. Green investment supports SDGs 7 and 9 through Targets 7.2 and 9.4, reflecting renewable-energy deployment and the upgrading of industrial infrastructure toward clean technology. Job quality is connected to SDG 8 (Decent Work and Economic Growth), specifically Targets 8.5 and 8.8, as it captures the dimensions of fair wages, job security, labour rights, and safety that underpin a just and inclusive energy transition.

¹ PCA is a dimensionality reduction approach that converts data into a new coordinate system in which the greatest variance lies along the first axis (the first principal component), the second greatest variance along the second axis, and so on. It is computed from the eigen decomposition of the data covariance matrix or the singular value decomposition (SVD) of the data matrix. Based on covariance matrix $C=(1/n)X^T X$; PCA solves the eigenvalue problem for $Cv_i=\lambda_i v_i$.

Employment is also linked to SDG 8 via Target 8.5 because the employment-to-population ratio reflects the extent of productive and inclusive labour-market engagement. Finally, life expectancy aligns with SDG 3 (Good Health and Well-being), notably Target 3.9, since improvements in environmental quality, working conditions, and access to essential services contribute directly to reductions in pollution-related morbidity and mortality. Together, these variables provide a multidimensional way through which the interactions between climate policy, labour markets, and public welfare can be assessed within the SDG framework.

4. Results and discussion

The findings presented in this study have direct relevance for SDGs 3, 7, 8, and 13. The negative employment effects of carbon pricing and green investment highlight labour-market trade-offs associated with early-stage de-carbonisation (SDG 13), while the positive effects on life expectancy support SDG 3 through pollution reduction and public-health benefits. The role of job quality reinforces the importance of decent work (SDG 8), particularly in ensuring that green transitions do not compromise worker well-being.

Table 2 shows that the average employment rate is 55.7% with a standard deviation of 5.8%, indicating that more than half of the population is employed, though with modest cross-country disparity. Life expectancy averages 78.9 years, reflecting good living standards, with a country having its average life expectancy as low as 67.3 years while another with the life expectancy standing at almost 85 years. This suggests developmental and healthcare variation among countries, especially between India and the US.

Table 2. Summary statistics, source: Authors' computation using Stata 17.0

Variables	Mean	SD	Min	Max
Employment (%)	55.720	5.764	43.701	66.751
Life expectancy (years)	78.894	4.561	67.282	84.56
RGDP per-capita (\$)	27858.88	18736.32	1399.454	65505.26
Labor Force Participation Rate	72.041	6.952	54.374	81.51
Mean Years of Schooling (Years)	10.489	2.794	5.495	14.296
Current Health Expenditure per-capita (\$)	3623.01	3262.319	55.469	12434.43
FDI (%)	2.041	1.152	0.118	4.527
Green Investment (%)	19.596	12.509	5	50
Carbon Pricing (€)	27.278	20.097	0.739	73.266
Job Quality	6.77e-10	1	-1.917	1.235

In Table 2, the average real GDP per capita is \$27,859, but with large variation reflected by standard deviation of about \$18,736 or wide range of \$1,399-\$65,505. This suggests that the sample consists of low-income and high-income countries. Labor force participation averages 72%, reflecting dynamic labor markets, while mean years of schooling (10.5 years) indicate reasonably high educational attainment, ranging from 5.5 in emerging economies to over 14 in advanced economies. Current health expenditure per capita averages \$3,623 but very wide gap as it ranges from \$55 to \$12,434, which further highlight the differences in healthcare systems. FDI inflows average 2.04% of GDP with also a modest disparity (shown by standard deviation of 1.15%).

Environmental indicators highlight important differences. Green investment (represented by renewables as a % of total energy consumption) averages 19.6%, but with high variation of 12.5%, suggesting divergence in the speed of energy transition policies. The average carbon pricing is estimated at €27.3 per ton of CO₂ equivalent but with a wide disparity as it ranges from €0.7 to €73.3). This indicates divergent carbon market readiness and regulatory commitment across the countries in the sample. Finally, the job quality index captures heterogeneous labor standards, with both high-quality and hazardous employment environments evident among the top green transition countries.

Table 3 shows the possibility of multicollinearity between variables in the estimated regression. For instance, Real GDP per capita is highly correlated with mean years of schooling (0.93) and labor force participation (0.80), and strongly with job quality (0.87). Similarly, mean years of schooling and job quality are highly correlated (0.88).

Table 3. Pair-wise correlation, source: Authors' computation using Stata 17.0

Variables	1	2	3	4	5	6	7
1 RGDP per-capita (\$)							
2 Labor Force Participation Rate	0.80						
3 Mean Years of Schooling (Years)	0.93	0.68					
4 Current Health Expenditure per-capita (ln)	-0.16	0.32	-0.06				
5 FDI (%)	0.08	-0.03	-0.17	-0.33			
6 Green Investment (%)	-0.69	-0.61	-0.67	-0.33	0.49		
7 Carbon Pricing (€)	0.60	0.36	0.59	-0.30	0.13	-0.46	
8 Job Quality	0.87	0.58	0.88	-0.18	-0.23	-0.67	0.56

In Table 3, carbon pricing is moderately correlated with GDP per capita (0.60), mean years of schooling (0.59), and job quality (0.56). Green investment shows strong negative correlations with GDP per capita (-0.69), mean years of schooling (-0.67), and job quality (-0.67). Overall, some variables are highly correlated, suggesting potential multicollinearity.

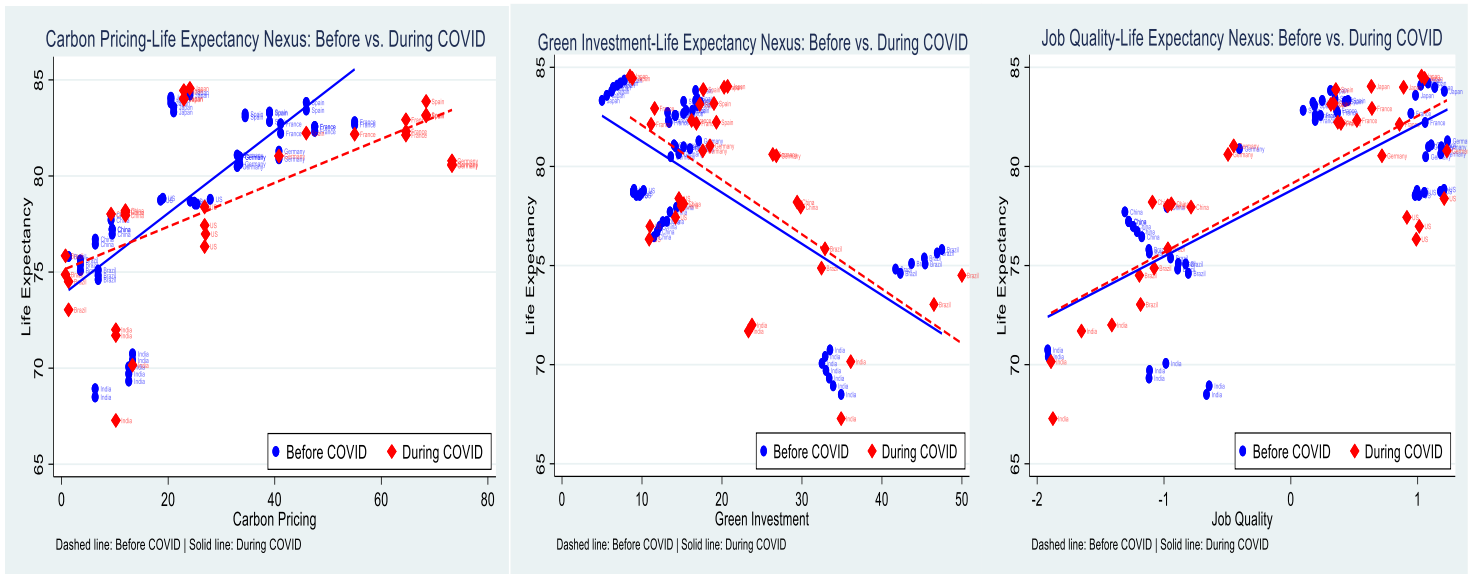


Figure 1. Relationship between life expectancy, and carbon Pricing, green investment & job quality

Left (first) chart in Figure 1 shows that carbon pricing correlates positively with life expectancy. The slope is steeper Pre-COVID, suggesting that before COVID-19, the impact of carbon pricing on life expectancy was stronger, possibly because environmental tax policies were linked to cleaner air and better health outcomes. During COVID, however, the line remains positive but flatter, implying the relationship weakened after the pandemic. COVID likely disrupted economic activity, healthcare systems, and environmental policy enforcement, reducing the short-run benefits of carbon pricing. The left chart shows that high-income countries (France, Germany, Japan, Spain) cluster in the upper-right, meaning coexistence of high carbon pricing and high life expectancy, while emerging economies (Brazil, China, India) cluster lower.

The middle (second) chart in Figure 1 suggests that both pre- and COVID periods lines slope downward, which is counterintuitive, but plausible. This may imply that higher green investment shares were concentrated in countries still developing or transitioning, where life expectancy is lower (e.g., Brazil, India, China), whereas developed countries (Japan, Spain, France) had lower green investment shares but already higher life expectancies. Pre-COVID and COVID period lines are nearly parallel, meaning the relationship remained consistently negative.

Finally, the right (third) chart shows also that both regression lines rise sharply, showing that better job quality aligns closely with higher life expectancy. The slopes are almost identical, with the post-COVID line only slightly above the during COVID one. This means despite the pandemic, improvements in job quality continued to support health outcomes. Countries like Japan, France, and Germany remain at the top, while India and Brazil occupy the lower end, consistent with global labor market disparities.

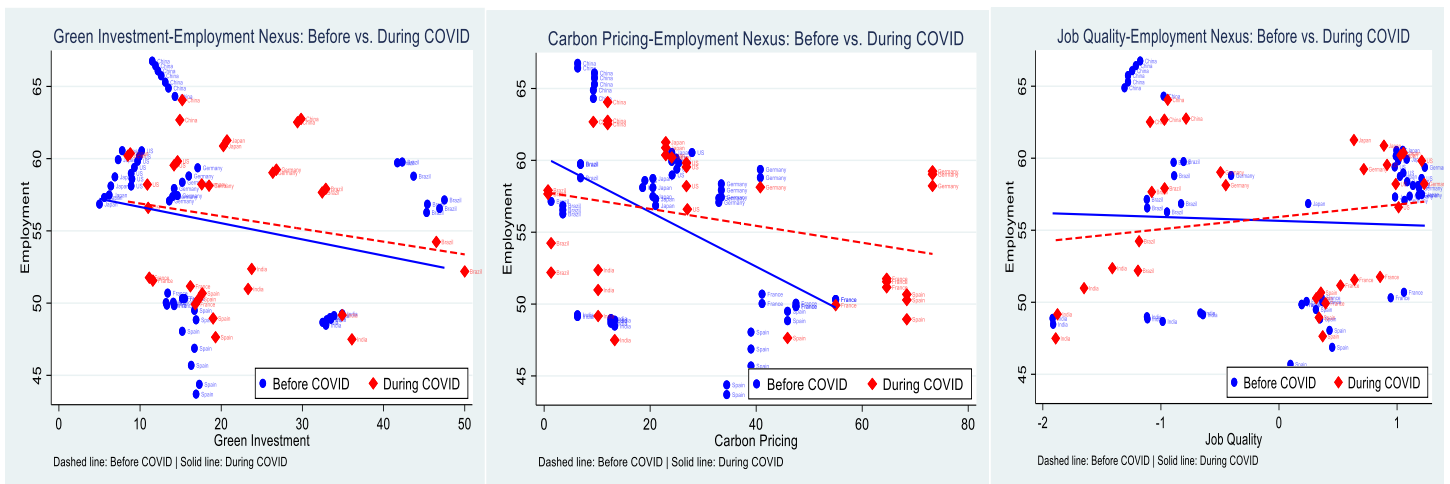


Figure 2. Relationship between employment, and carbon pricing, green investment & job quality

Middle (second) chart in Figure 2 shows that higher carbon pricing is associated with a lower decline in employment levels pre-COVID. The line shows a stronger negative slope. The relationship weakens after COVID-19, with a flatter negative slope, indicating that rising carbon pricing is not significantly associated with drops in employment after the pandemic. Some countries (Germany and Spain) have higher carbon pricing levels but mixed employment outcomes post-COVID. Countries with low carbon pricing (Brazil, India and China) maintain higher employment levels. Overall, COVID appears to reduce the negative effect of carbon pricing on employment, possibly due to policy responses, economic adjustments, or shifts in labor markets.

Before COVID-19, there is a slight negative relationship between green investment and employment, with the line trending slightly downward (first chart by the left). During COVID-19, the slope becomes slightly less negative, suggesting green investment is less tied to declining employment or may even be stabilizing employment in some contexts. Thus, the negative relationship between green investment and employment weakens during COVID-19, possibly as green investment plays a stabilizing or counter-cyclical role during recovery. China, Brazil, Germany, and the US cluster around higher green investment and higher employment, while Spain and India span low employment across both periods.

The third (right) chart in Figure 2 shows that job quality has virtually no effect on employment, reflected by a nearly flat line. In the COVID period, however, the line trends become slightly positive, indicating a small positive relationship between better job quality and higher employment levels after COVID-19. Countries with better job quality (to the right) generally see higher employment, especially observed in during COVID data for developed economies (US, Germany, Japan). India and Brazil, with lower job quality, have consistently lower employment.

4.1. Findings from employment models

Table 3 present results on early impacts of the green transition on employment among eight major green employing economies.

Table 4. Effects of carbon pricing, green investments and job quality

Employment	(1) Fractional	(2) PCSE	(3) FGLS
Real GDP Per-Cap (ln)	-0.127*** (0.042)	-0.036*** (0.011)	-0.035*** (0.008)
Labor Participation	0.015*** (0.006)	0.007*** (0.001)	0.008*** (0.001)
Mean Years of Sch.	0.045*** (0.017)	0.009** (0.004)	0.004 (0.003)
FDI	0.011 (0.016)	0.0004 (0.002)	0.0007 (0.001)
Green Investment	-0.005* (0.002)	-0.0006* (0.0004)	-0.0004 (0.0003)
Carbon Pricing	-0.005*** (0.001)	-0.001*** (0.0003)	-0.001*** (0.0002)
Job Quality	-0.027 (0.038)	-0.0006 (0.003)	0.001 (0.002)
Constant		0.331*** (0.050)	0.281*** (0.041)
Year Effect	Yes	Yes	Yes
Number of Countries	8	8	8
Number of Years	11	11	11
Observations	88	88	88
VIF	3.56	3.56	3.56

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

The most consistent and statistically significant finding across all three models is the significant negative effect of carbon pricing on employment. Each coefficient for carbon pricing is negative and significant at the 1% level. This suggest that, in the short to medium term, €10 rise in carbon pricing tend to cause 0.1-0.5% reduction in the employment. This is a pointer to the possibility of *creative destruction* of the green transition wherein where job losses in carbon-intensive sectors are not yet fully offset by new employment opportunities in green sectors, leading to a net negative effect on the overall employment rate.

Similarly, the findings for green investment is also negative and weakly significant. The coefficient is negative and statistically significant in two of the three models (Fractional and PCSE), though the effect is small in magnitude. The most surprising result is the consistently insignificant effect of job quality on employment in the world's leading transition economies. The coefficient for the job quality index is negative in two models and positive in one, but it is not significant in any of the models. Thus, improvements in job quality, in terms of better wages,

security, greenish of the jobs and working conditions, are not significantly linked to changes in the overall employment rate. Among the control variables, real GDP per capita is negative and significant, which implies that as economies become richer, the employment rate declines, possibly reflecting structural shifts toward higher productivity sectors. Labor participation rate is also positive and significant that is higher participation directly correlates with higher employment levels. Similarly, mean years of schooling is positive and significant, indicating that education promotes employment, though the effect diminishes in more efficient estimations. Variance inflation factor of 3.56 indicates no serious multicollinearity issue.

Table 5. Effects of carbon pricing, green investments and job quality: pre vs. COVID period

Employment	Pre-COVID		COVID Period	
	Fractional	Two-FE	Fractional	Two-FE
Real GDP Per-Cap (ln)	-0.06** (0.027)	-0.001 (0.016)	-0.137*** (0.044)	-0.005 (0.028)
Labor Participation	0.009** (0.004)	0.004** (0.002)	0.017*** (0.006)	0.006*** (0.002)
Mean Years of Sch.	0.041** (0.018)	0.013 (0.009)	0.040*** (0.015)	0.010* (0.005)
FDI	0.026 (0.021)	0.003 (0.007)	-0.013 (0.012)	-0.007* (0.004)
Green Investment	-0.007*** (0.002)	-0.002** (0.0008)	-0.004** (0.002)	-0.001* (0.0001)
Carbon Pricing	-0.009*** (0.002)	-0.004*** (0.0008)	-0.003*** (0.0008)	-0.001*** (0.0003)
Job Quality	-0.043 (0.037)	-0.028** (0.014)	-0.006 (0.039)	-0.033 (0.022)
Constant		0.260*** (0.037)		0.115 (0.147)
Year Effect	Yes	Yes	Yes	Yes
Number of Countries	8	8	8	8
Number of Years	7	7	4	4
Observation	56	56	32	32

Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

The results in Table 5 provide evidence on how the relationship between environmental policies, sustainable investments, and labor market outcomes evolved across two distinct periods, before and after the COVID-19 pandemic. Across both the pre- and during COVID periods, carbon pricing remains a negative and significant in influencing employment, though the magnitude of this effect declines after the pandemic. Specifically, before the COVID-19, carbon pricing coefficient ranges from -0.009 to -0.004 while after the effect declined to -0.003/-0.001. This effect can be interpreted as a reflection of adjustment costs in carbon-intensive industries, where firms reduce production or employment in response to higher operating costs linked to emissions compliance. One plausible explanation is that post-pandemic recovery programs and green stimulus packages in many economies partially cushioned firms and workers from the full employment costs of carbon pricing.

Green investment also shows a consistently negative and significant effect on employment, both before and after COVID-19. In the pre-COVID periods, the effect ranges from -0.007 to -0.002, which indicate that higher green investments lead to lower employment. Although the effect remains negative and significant in the post-COVID periods; the effect declines -0.004/-0.001. This finding is line with the notion that green investments are often capital-intensive and technologically driven, particularly in their early phases, leading to limited short-run job creation. Many green infrastructure projects and clean technology transitions require significant upfront spending on physical capital. While green investment initially brings about employment trade-offs, the post-COVID moderation of its negative impact points to a gradual evolution toward more labor-inclusive green growth.

The effect of job quality on employment is negative in both periods but only statistically significant in two-way fixed effect model for pre-COVID. This suggests that before the pandemic, improvements in job quality, likely reflecting higher wages, better working conditions, or stronger labor rights, were associated with slight reductions in employment. In contrast, during the COVID period, the job quality is not significant across specifications, implying that the relationship between job quality and employment became more neutral. The pandemic appears to have weakened the trade-off between job quality and employment.

4.2. Findings from life expectancy models

The results from Table 6 reveal important insights into how environmental policy instruments and labor market conditions interact to shape human well-being across countries. In Table 6, the results for carbon pricing present a positive and significant effect on life expectancy. The variable increases in magnitude from 0.07 to 0.080. This consistent finding suggests that higher carbon prices are associated with increases in life expectancy. Surprisingly,

green investment shows a negative and significant coefficient in the PCSE model, though the effect becomes insignificant in the FGLS and pooled estimations. This initial negative association appears counterintuitive since green investment is expected to enhance sustainability and welfare.

However, this result likely reflects the short-term transitional costs of large-scale green projects. Green investments, particularly in infrastructure and technology, often entail high capital intensity, construction-related pollution, and temporary resource reallocation that may not immediately translate into improved living standards or environmental health. The results for job quality show a strong positive and significant relationship with life expectancy in the FGLS and pooled models. This indicates that higher job quality substantially enhances life expectancy. The mechanism behind this relationship is intuitive and well-documented in labor and health economics.

Table 6. Effects of carbon pricing, green investments and job quality on life expectancy

Life Expectancy	PCSE	FGLS	Pool
Real GDP Per-Cap (ln)	4.847*** (0.528)	4.796*** (0.327)	5.036*** (0.500)
Current Health Exp. (ln)	2.422*** (0.742)	3.297*** (0.385)	3.930*** (0.913)
Mean Years of Sch.	-1.056*** (0.200)	-1.180*** (0.143)	-1.494*** (0.221)
Green Investment	-0.064*** (0.022)	-0.021 (0.015)	-0.0004 (0.031)
Carbon Pricing	0.065*** (0.013)	0.070*** (0.007)	0.080*** (0.016)
Job Quality	0.074 (0.206)	0.805*** (0.287)	1.616*** (0.563)
Constant	35.16*** (4.955)	33.48*** (2.894)	31.98*** (5.308)
Year effect	Yes	Yes	Yes
Number of Years	11	11	11
Number of Countries	8	8	8
Observations	88	88	88
VIF	3.28	3.28	3.28

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

The results in Table 7 reveal important divergence in the effects of carbon pricing, green investment, and job quality on life expectancy between the pre- and during COVID periods. The pre-COVID results establish a clear and positive role for carbon pricing in improving population health. The variable is positive and highly significant in both the Panel Corrected and Pooled models. This robust finding indicates that in the period of stable economic conditions before the pandemic, higher carbon prices were consistently associated with increased life expectancy. The mechanism is certainly the direct health co-benefit of reduced air pollution, as carbon pricing leads to a decrease in the burning of fossil fuels, thereby lowering the incidence of respiratory and cardiovascular diseases that shorten lives. In contrast, the relationship between green investment and life expectancy in the pre-COVID and during COVID era is statistically insignificant in both models.

Table 7. Effects of carbon pricing, green investments and job quality on life exp.: pre vs. COVID period

Variable	Pre-COVID		During-COVID	
	Panel Corrected	Pool	Panel Corrected	Pool
Life Expectancy				
Real GDP Per-Cap (ln)	5.100*** (0.539)	5.848*** (0.577)	4.258*** (1.106)	3.342*** (1.108)
Current Health Exp. (ln)	2.828*** (1.012)	5.037*** (1.213)	3.319*** (1.265)	4.554*** (1.451)
Mean Years of Sch.	-0.976*** (0.221)	-1.676*** (0.334)	-1.027*** (0.377)	-1.343*** (0.402)
Carbon Pricing	0.076*** (0.022)	0.115*** (0.024)	0.062*** (0.021)	0.077*** (0.022)
Green Investments	-0.005 (0.037)	0.047 (0.040)	-0.056 (0.044)	0.005 (0.054)
Job Quality	0.201 (0.173)	1.639** (0.746)	0.445 (0.759)	2.651* (1.333)
Constant	29.73*** (6.090)	21.33*** (6.536)	38.33*** (9.159)	46.64*** (7.955)
Number of Years	7	7	4	4
Number of Countries	8	8	8	8
Observations	56	56	32	32

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Job quality presents another important dimension of the analysis. Before COVID-19, the pooled model reveals a positive and significant effect of between job quality on life expectancy. This indicates that in more stable pre-pandemic labor markets, countries with better-quality jobs enjoyed higher life expectancy. Such jobs likely enhanced individuals' access to healthcare, reduced work-related stress, and improved living standards. During COVID-19, the pooled model again shows a positive and significant effect as well as larger effect. This pattern suggests that even though the pandemic disrupted labor markets globally, nations that maintained or improved job quality during recovery periods experienced better health outcomes. Quality employment likely acted as a protective factor by ensuring social security, stable income, and continued access to medical care during and after the pandemic.

4.3. Discussion of findings

One of the key findings from the analyses above is that carbon pricing negatively and significantly affects employment across the leading energy transitioning countries. This finding is plausible as the introduction and increment of carbon price, through carbon tax or emission trading scheme, translate into higher operating costs especially for firms in carbon-intensive sectors. Higher operating costs can lower profitability, thereby motivate the firms to reduce production level, which subsequently lower employment. The finding is consistent with that of Aguilar, González and Hurtado (2022), which observed an increase in the carbon price causes a reduction in employment rate in Spain. Similarly, the finding aligns perfectly with those of Wei and Yip (2025) in British Columbia, and Yoshino, Rasoulinezhad and Taghizadeh-Hesary (2021) in Japan. On the contrary, this finding contradicts that of Cao (2023), which discover that the carbon pricing policy does not significantly impact the unemployment rate across the 33 countries that implemented the policy.

The effect of carbon pricing is further decomposed across two distinct periods: pre and during-COVID-19 era. Although carbon pricing remains negative and significant across the periods, the effect is larger and stronger before the COVID-19 than during and after the pandemic. The pandemic might have altered the transmission of carbon pricing into employment by introducing huge exogenous labour-market shocks such as disruptions to production. The carbon-pricing policy may have been modified during COVID-19, thereby plummeting its employment-impact magnitude.

Another finding is that green investment has negative and significant effect on the employment. This sounds counterintuitive but it is plausible as it may reflect many interesting underlying dynamics. One of the dynamics is that the finding may suggest the capital-intensive nature of early-stage renewable energy projects that require massive investment in technology and infrastructure before creating employment opportunities. Another dynamic is that the finding might have indicated that these investments are focusing more on productivity gains and creation of high-skilled green jobs while displacing a larger number of low-skilled jobs in traditional industries, leading to a net negative effect in the short run. This finding resonates with that of Zhang et al. (2023) in China but contrasts the finding of Cui et al. (2021) also in China and Ibrahim and Sameh (2020) in Egypt.

The impact of green investment is also stronger pre-COVID than during COVID and the plausible explanation for this, is that during the COVID-19 pandemic, most countries especially energy-transitioning economies, experienced serious fiscal stress, supply-chain breakdowns, and capital market contractions. These shocks constrained both public and private investment flows, including those targeted at green projects.

Job quality, reflecting job security, labor rights, good pay and greenish of the job, is also found to negatively affect employment among the countries during COVID. The negative effect of job quality on employment post-COVID can be justified by the economic and labor market disruptions that accompanied the pandemic. During COVID-19, many countries encountered weak private investment, reduced firm profitability, and tighter fiscal conditions that made it difficult for employers to sustain high-quality or well-paying jobs. Conversely, another important finding is that carbon pricing has a positive and significant impact on life expectancy.

The mechanism is that carbon pricing works by discouraging fossil fuel combustion, which leads to immediate and localized improvements in air quality. Reduced emissions of particulate matter and other pollutants directly decrease mortality from respiratory and cardiovascular diseases. This finding validates Chen and Wang (2023) finding that carbon tax and emission trading scheme (ETS) reduce morbidity and mortality in China. The positive impact of carbon pricing is larger and stronger before the COVID than does it after the pandemic. The plausible reason could be that, prior to the pandemic, carbon pricing policies were more meritoriously implemented and supported by stable economic growth and public health systems. These conditions allowed revenues from carbon taxes and emissions trading schemes to be reinvested in cleaner energy, healthcare, and pollution control that improved environmental quality and human health.

During the COVID, however, many governments relaxed carbon pricing mechanisms to prioritize short-term economic recovery, industrial support, and employment retention. The weakened enforcement of environmental regulations and fiscal reallocations away from climate initiatives reduced the health co-benefits of carbon pricing. Green investment, on the other hand, has a negative and significant impact on life expectancy. This finding Shaari et al. (2024) finding that green investment enhances life expectancy in Philippines and Thailand. The possible explanation for this finding, is that the investments may divert substantial resources away from immediate, life-

saving healthcare services, infrastructure, and social programs. Finally, job quality is positively significant in determining life expectancy. Quality jobs, characterized by adequate wages, job security, social protection, greenish of the work and safe working conditions, directly improve workers' physical and mental health. Moreover, higher job quality increases access to healthcare, reduces occupational hazards, and lessens financial stress, all of which contribute to longer and healthier lives.

5. Conclusion

Cross-country patterns reveal important heterogeneity. Advanced economies such as Germany, France, Japan, Spain, and the United States, characterized by higher carbon pricing and stronger institutional capacity, experience smaller employment losses and stronger improvements in life expectancy. In contrast, emerging economies like India, Brazil, and China experience sharper employment pressures due to lower labour-market flexibility, higher dependence on carbon-intensive industries, and evolving green-innovation systems. These differences emphasise the need for tailored policy approaches in implementing SDG-aligned climate strategies.

This study examined the dual impacts of carbon pricing, green investments, and job quality on employment and life expectancy across eight major energy-transitioning economies. The study decomposed the impacts across the pre- and during-COVID-19 periods. The results provide evidence that while carbon pricing and green investment policies are essential tools for achieving long-term sustainability, their short-term labor market effects can be adverse.

The analyses reveal that carbon pricing consistently exerts a negative and statistically significant effect on employment, suggesting that the green transition may suggest early *creative destruction*, where job losses in carbon-intensive industries are not yet fully compensated by new job opportunities in green sectors. However, this effect is notably stronger before the COVID-19 pandemic, likely due to the policy adjustments and palliatives introduced during post-pandemic recovery programs. Green investments are also found to have a negative effect on employment, accentuating the capital-intensive and technology-driven nature of early-stage green transitions. The effect, however, weakens during the COVID-19, implying a gradual shift toward more inclusive and labor-absorptive green growth patterns as economies recover and adapt. Job quality, while largely insignificant in its effect on employment, reflects a dynamic post-pandemic labor environment in which maintaining or improving working conditions, wages, and job security became increasingly challenging amid fiscal constraints and weak private sector recovery.

In contrast to their employment effects, both carbon pricing and job quality have positive and significant impacts on life expectancy, indicating important health co-benefits of environmental and labor market reforms. The positive health impact of carbon pricing is particularly evident before COVID-19, highlighting the effective reinvestment of carbon revenues in public health, clean energy, and pollution control measures during periods of economic stability. Similarly, higher job quality substantially improves life expectancy by promoting access to healthcare, reducing work-related stress, and ensuring income security. Conversely, the negative and sometime insignificant effect of green investment on life expectancy highlights the delayed nature of its benefits, where capital-intensive projects may initially divert resources from immediate welfare-enhancing activities.

Overall, the study concludes that while carbon pricing and green investments remain indispensable for sustainable development, their short-term labor market disruptions require complementary policies that enhance labor mobility, reskilling, and social protection. Policymakers must therefore balance environmental ambition with inclusive employment strategies to ensure that the transition toward a low-carbon economy yields not only ecological sustainability but also equitable and health-enhancing outcomes for society. The findings call for a unified policy framework that recognizes and manages the trade-offs of the transition.

Carbon pricing remains essential for driving decarbonization and delivering health benefits, but its implementation must be coupled with active labor market policies, retraining programs, and targeted support for vulnerable regions and workers to mitigate employment losses. Simultaneously, policymakers must ensure that green investment is channeled toward not only technological deployment but also job-rich projects and that the quality of new jobs in the green economy is a paramount concern. Ultimately, a successful transition is one that does not force a choice between climate action, decent work, and public health, but one that strategically pursues them in concert.

This study contributes to global discussions by examining how carbon pricing, green investment, and job quality influence employment and life expectancy in eight leading energy-transitioning economies. The results show that while carbon pricing and green investments are essential for achieving SDGs 7 and 13, their early-stage effects impose short-term employment pressures, especially in emerging economies. Job quality, though less influential on employment, significantly improves life expectancy, supporting SDG 3. Across the COVID-period, labour-market disruptions moderated the negative effects of carbon pricing and green investment but did not eliminate them.

Policy implications highlight the need for strong labour-market protections, retraining programs, green-skills development, and health-sector reinvestments to ensure that climate policies advance SDGs 3, 7, 8, and 13 simultaneously. A just and socially inclusive green transition must therefore prioritise employment stability, worker well-being, and equitable health improvements while accelerating decarbonisation.

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