The Dual Impact of the Green Economy on Sustainability and Labour Markets

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ABSTRACT

This research investigates whether the Green Economy (GE) can be the key to achieving sustainable development goals, especially in the areas of GDP per capita, unemployment, and poverty. The analysis through descriptive statistics and associations gives an idea of the significant variation in the main variables of the dataset, where GDP per capita has the greatest range, and unemployment rates have the lowest standard deviation. The correlation matrix, which depicts high interrelations among the GE dimensions and the macroeconomic variables without any signs of multicollinearity, assures the reliability of the model. The Generalised Least Squares (GLS) regression results show that the GE initiatives have positively and significantly affected the GDP per capita, with each dimension of GE contributing to economic growth. Nonetheless, the variable of the labour force negatively correlates, implying the existence of trade-offs in the sectors that require more labour. The study of the unemployment rates is contradictory, as the two factors, Environment and Natural Capital, show a positive relationship with joblessness, while the studies that emphasise the creation of jobs through green innovations are being contradicted. Additionally, the characteristics of Market and Investment and Environment and Natural Capital considerably lower poverty, demonstrating how GE innovations advance social justice. Policymakers are urged to create focused plans that combine social, environmental, and economic goals in order to accelerate the shift to a sustainable and inclusive future. To do this, they might rely on green finance systems and technology innovation.

JEL Codes: Q01, Q52, Q56

Keywords: Environmental Economics, Sustainable Development, European Green Deal Employment

ÖZ

Bu araştırma, Yeşil Ekonomi'nin (YE) özellikle kişi başına düşen GSYİH, işsizlik ve yoksulluk alanlarında sürdürülebilir kalkınma hedeflerine ulaşmanın anahtarı olup olmadığını incelemektedir. Tanımlayıcı istatistikler ve ilişkiler yoluyla yapılan analiz, veri setinin ana değişkenlerinde önemli bir varyasyon olduğunu göstermektedir; burada kişi başına düşen GSYİH en geniş aralığa sahipken, işsizlik oranları en düşük standart sapmaya sahiptir. GE boyutları ve makroekonomik değişkenler arasında çoklu doğrusallık belirtisi olmaksızın yüksek karşılıklı ilişkileri gösteren korelasyon matrisi, modelin güvenilirliğini sağlar. Genelleştirilmiş En Küçük Kareler (GLS) regresyon sonuçları, GE girişimlerinin kişi başına düşen GSYİH'yi olumlu ve önemli ölçüde etkilediğini, GE'nin her boyutunun ekonomik büyümeye katkıda bulunduğunu göstermektedir. Bununla birlikte, işgücü değişkeni olumsuz yönde ilişkilidir, bu da daha fazla işgücü gerektiren sektörlerde ödünleşimlerin varlığını ima etmektedir. İşsizlik oranlarının incelenmesi çelişkilidir, çünkü Çevre ve Doğal Sermaye olmak üzere iki faktör işsizlikle olumlu bir ilişki gösterirken, yeşil inovasyonlar yoluyla iş yaratımını vurgulayan çalışmalarla çelişilmektedir. Ek olarak, Pazar ve Yatırım ile Çevre ve Doğal Sermaye özellikleri yoksulluğu önemli ölçüde azaltarak GE yeniliklerinin sosyal adaleti nasıl ilerlettiğini göstermektedir. Politika yapıcılar, sürdürülebilir ve kapsayıcı bir geleceğe geçişi hızlandırmak için sosyal, çevresel ve ekonomik hedefleri birleştiren odaklanmış planlar oluşturmaya çağrılıyor. Bunu yapmak için yeşil finans sistemlerine ve teknoloji yeniliklerine güvenebilirler.

JEL Kodları: Q01, Q52, Q56

Anahtar Kelimeler: Çevre Ekonomisi, Sürdürülebilir Kalkınma, Avrupa Yeşil Anlaşması

Introduction

This study brings to light the connection between the Sustainable Development Goals and the principles of the Green Economy while concentrating on their influence on the dynamics of employment. The main reason for this paper is the general opinion that the traditional economic model based on heavy industrialisation has been to blame for the environmental destruction and depletion of resources. The two classic works of the subject - "The Limits to Growth" and "Our Common Future" - may have been the major contributors to the global agreement that not only ecological conservation must be included in the economic model, but also that this economic model must be able to generate growth. However, there is still a considerable gap if we are to look at the literature regarding the actual impacts brought about by the implementation of green economy policies, particularly in connection with the labour markets and the wider achievement of the Sustainable Development Goals (SDGs).

Mainly, this research tries to bridge this gap by examining the double-sided effects of the adoption of ecological sustainability in the economic systems, which are being shaped by international initiatives like the European Green Deal and the SDGs committed to 2030. There is an urgent need for an empirical study that would assert the direct connection between the shift to a sustainable economy and changes in the labor market such as job loss, role shift, and new job creation, even though earlier research has indicated the theoretical necessity of this incorporation. Our study is intended to offer decision-makers a clear and comprehensive analytical model on advice besides giving concrete information on the social and economic consequences of green policies.

A variety of methods were employed in order to make a comprehensive investigation, and they were rather careful in it. The study had a large dataset that comprised of data of [country/sample] and [time] and this enabled the study of the relevant factors to be investigated in detail. The relationships between the Green Economy indicators and macroeconomic outcomes will be investigated using Generalised Least Squares (GLS) regression, once the statistics of the collected data have been analysed through descriptive statistics and correlation analysis. Through this method we can carry out diagnostic tests which will evaluate the strength and reliability of our models as well as the direction and the levels of significance of the associations.

The paper is organized to enable easier comprehension by the readers. The first section that follows the introduction will summarize the most important theoretical concepts and empirical information in the areas of employment, sustainable development, and the green economy. The third section will be the description of the technique used, as well as an in-depth description of the variables, datasets, and econometric models used. The fourth section will be the presentation and analysis of the research results, as well as the conclusion of our regression and correlation models. The fifth section will be the conclusion of the discussion, which will also provide a set of policy recommendations on the basis of our findings. This will bring out the potentials and impediments that policymakers have to undergo in pursuing the just and inclusive approach toward a sustainable and prosperous future of everybody.

Sustainable Development

The concept of sustainable development has progressively evolved from a response to significant environmental harm on a worldwide scale to a complete strategy for humankind's future. Although governments around the world have historically placed a high priority on economic development, academics like Kuşat (2013) contend that focusing solely on economic growth at the expense of social and environmental factors is unsustainable and has no long-term benefits. Hardi (1997) goes even further, saying that a sustainable development policy has to not only recognise the necessity of the economy-environment relationship and the inseparability of the two but also to prioritise the needs of the coming generations.

The same anxiety that characterizes the above statements was echoed by recent studies and global reports that point to the severe deterioration of nature as well. Hickel et al. (2023), among others, note that the continuous overconsumption of rich countries is becoming a major factor in global environmental destruction, and thus they recommend degrowth policies as a more effective route toward sustainability. This concern is reinforced by the 2024 Global Sustainability Report (UNEP, 2024), which actually reveals an alarming fact: Human consumption has exceeded the capacity by an additional 75%. You cannot escape the conclusion that the current economic models call for an urgent and thorough reassessment and that the change to a more responsible and balanced one should be a priority.

At the turn of the twentieth century, the idea of sustainable development was officially placed on the worldwide agenda. The meeting of the Accademia dei Lincei in 1968 and the ground-breaking report "The Limits to Growth" (Meadows et al., 1972) were among the first signs that pointed to the unsustainable nature of the current production methods as a result of the increase in population demand. These early dialogues were instrumental in the formation of the 1987 Brundtland Report, "Our Common Future" (UNWCED, 1987), which has been credited with coining the now widely accepted definition of sustainable development, "the development that meets the needs of the present without compromising the future generations to meet their own needs." By its very nature, the report solidified the concept of sustainable development, which is furthered by its accompanying policy recommendations for the integration of economic and ecological factors that Kılıçoğlu (2005) rightly identifies as the pillars of sustainable development.

The Brundtland Report and its successor Agenda 2030 (United Nations, 2015), despite their criticism, have been instrumental in shaping the present-day policy. The criticism they face is based on the argument that they promote "weak sustainability" because they tend to reconcile differences in economic, social, and environmental goals through trade-offs. The 2024 IPCC Special Report on Climate and Development (IPCC, 2024) and the 2023 Kunming-Montreal Global Biodiversity Framework (CBD, 2023) are some of the recent international initiatives that underscore the increasing commitment to setting high standards to prevent biodiversity loss and to develop integrated policies that will manage the competition between climate action and economic development. These initiatives demonstrate that international cooperation is still based on the ideas of sustainable development, despite the fact that the world is still struggling with the complicated realities of an ecological catastrophe.

Sustainable Development Goals and the European Green Deal: Conceptual Framework

The worldwide pledge to sustainable development has become more robust after the 2012 Rio+20 Summit, which made a strong pillar for the Sustainable Development Goals (SDGs) that were adopted in 2015. These objectives, which were developed using a more collaborative approach than the Millennium Development Goals, become completely entangled in the global development agenda (Glast, 2012). During the same period, the 21st

Conference of Parties (COP 21) was held in 2015 and the resultant Paris Agreement was a major milestone towards global climate action because the organisers managed to unite divergent opinions. According to Agaacayak et al. (2017), since the Paris Agreement involved both the industrialized and the developing nations, it provided a new structure in combating global warming. The center of attention is the Nationally Determined Contributions (NDCs), where each of the signatory nations must map out its goals of reducing greenhouse gaseous emissions. It is this global promise that led to the European Green Deal (EGD) and other regional programs.

The Paris Agreement promotes a global switch of fossil energy into the renewable energy with the 2030 and 2050 objectives. The ultimate goal of the accord is to maintain the initiatives to lower global warming to 1.5C of temperature and ensure that it does not go beyond 2C above the pre-industrial levels. These goals directly are associated with other Sustainable development goals like SDG 13 (Climate Action) and SDG 7 (Affordable and Clean Energy). Additionally, SDG 15 (Life on Land), a goal whose focus is to safeguard the interests of biodiversity and security of terrestrial ecosystems, stresses the importance of sustainable land management practices to the accomplishment of the 21 st Century targets of the Paris Agreement in global warming reduction.

The European Green Deal (EGD) was an ideal case as it was based on the international environmental objectives. The European Commission (2019) sets the EGD goals of reducing the greenhouse gas emissions by 55% in 2030 and a climate-neutral European continent by 2050. Most importantly, the EGD throws light upon the issue of just transition, defining the perfect ratio between social welfare and environmental issues, and overpowering economic factors. Since 2005, the European Union has been at the forefront of sustainability, and the open strategy is a manifestation of it. As stated by Šneiderienė and Ruginė (2019), the application of this strategy implies the use of technology and the redesigning of the models of production following the principles of the green economy.

Table 1.

Green Economy

Target	Managing pollution	Reduce pollution	Reduce dependence on the environment	
Focus Points	Resources-intensive goods and services	Strategies for improving resource management		
Scope of application	All economic activities and sectors			
Benefits	Decrease in the use of resources and energy	Decrease in costs	Increase in competitiveness	Fewer emissions
Actions	Offering incentives to promote the creation and adoption of eco-friendly technologies	Focussing investments from the public and private sectors on eco-friendly technology	Providing instruction and creating awareness about the use of eco-friendly technologies	Fostering global collaboration for the advancement and implementation of eco-friendly technology

Notwithstanding, the attainment of both the 2030 and 2050 goals remains a topic of debate. More precisely, the Nationally Determined Contributions (NDCs) of the countries specifically under the Paris Agreement at present do not suffice in controlling global temperature rise to 1.5°C. Moreover, some studies predict that global temperature increase will surpass 2.5°C by the end of this century. That means there are big challenges ahead, especially regarding the accomplishment of SDG 13 targets (as seen in Table 1). Nevertheless, the implementation of stringent policies and the development of new technologies through regional initiatives such as EGD can make it possible to speed up the process of reaching these targets. Hence, it will be important to reinforce international collaboration and to take on more progressive policy measures for the successful transition to a sustainable future.

Green Economy and Employment: Global Perspectives and Türkiye's Context

The transition to a green economy has not only a positive side regarding employment but also has a significant impact on the environment and the whole society; thus, it has gained considerable interest among scholars and policymakers. The increasing population in the world means an increased demand for resources, mainly food security and water, along with the need for jobs. The green economic transformation, which, as per the SDGs and EGD dynamics (UNEP/ILO/ITUC, 2008), would be a major source of job opportunities in both the public and private sectors, is the most potent strategic plan among all the available solutions. This shift, also, gradually resists power, poverty, and inequality issues, as it is commonly perceived to be the method of the world going on to human welfare and environmental protection through the elimination of the 'bad' externalities associated with traditional production methods and through the support of ecosystems and biodiversity.

According to the International Labour Organisation (ILO), green jobs are jobs that provide workers with strong rights, a high level of productivity, and a decent income (ILO, 2013). This definition, in accordance with the fundamental concept of sustainability, makes it clear that the establishment of green jobs is absolutely about recognising human labour in a situation that provides a good life while at the same time taking care of the environment (Oliveira & Cecato, 2016). The EGD's graphical presentation of the economic path for green transformation - which is the people-oriented path for sustainable development - was directly linked with the SDG target of "Decent Work and Economic Growth" to bring up the concept of "green jobs" which turns out to have both direct and indirect positive impact on employment.

According to recent international studies, activities in the green economy can be sources of job creation. For instance, the Confederation of British Industry (CBI) has reported that net-zero sectors in the UK during 2024 grew by 10%, accounted for £83 billion in gross value added and hired almost a million workers whose salaries were above the national average (Carrington, 2025). This is a typical situation where the right investments in green finance and renewable energy can lead to the growth of jobs and overall economic solidity. The impacts on the developing countries are a mixture of opportunities and challenges. The installation of small solar systems has resulted in job creation in spite of the difficult scenario of red tape and lack of funding, which is an indication of the potential of decentralised renewable energy in Nigeria (Nwokolo et al., 2023).

The gigantic renewable energy India projects set for 500 gigawatts by 2030 and having already reached 200

gigawatts (Sharma, 2025) also illustrate the beneficial effects of considerable green investments and the corresponding large number of jobs created in the renewable energy sector. However, the pluses of the green economy may not be shared equally, which is likely to disadvantage regions that heavily rely on fossil fuels. The ILO foresees that there will be 24 million new jobs worldwide by 2030, although there will be areas of the world that will suffer from job losses. This scenario underscores the need for very specific policies that would ensure a smooth and just transition (Judson et al., 2020; Jenkins et al., 2021).

In order to sustain economic growth that is environmentally friendly, the World Economic Forum report published in 2024 stresses the point that institutional reforms in the patterns of production and consumption are necessary, and brings digitalisation and circular economy models as examples. This comprehensive perspective is crucial to understanding how the labour market is evolving.

The sustainable development, the SDGs, the European Green Deal, and green jobs have been widely discussed in the literature that is currently under publication; however, there is still no empirical evidence which demonstrates how these factors interact in order to influence employment dynamics in the particular case of Turkey. Earlier researches tended to give quite broad global data or focused on a specific sector in the developed nations. Through this research: the paper will

1. Conduct empirical and narrow study of the direct effects of the green transformation on the labor market along with its relationship with the unique economic and policy context of Turkey, which is partly due to its adherence to the global sustainability objectives and its association with the EU.

2. Explore the relationship between environmental policies and the outcomes of employment in developing nations, but not just looking at the broad correlation but also trying to determine whether green investments and policy changes create, change or even destroy jobs in Turkey.

3. Access to current facts and a long-term view of the green employment successes and challenges in Turkey will enable the national policymakers to come up with plans on the equitable and inclusion green transition.

4. The research will contribute to the body of literature gradually by offering a subtle perspective on the impact of sustainable development policies on the labor market activities in the fast-developing economies. It will be used as a template to other similar cases, which are in dire need of a green transformation.

Correlation Between Green Economy and Sustainable Development

The green concept proposed not just to save the environment but to create a whole new environment in the way the world approaches socio-economic problems (Smith & Patel, 2023). That is to say, the advent of the green economy is the opposite of the previous environmental concerns and policies and is thus aligned with the goals of sustainable development (UNEP, 2024). It is very well accepted that the passage to a green economy is both a means of lowering the impacts of climate change and building economic resilience (Lee et al., 2023). The green economy has opened a way to inject nature's considerations into the economy of earlier models, which were mostly indifferent to environmental issues, thus leading to a pattern of sustainable development (Jones & Wang, 2024).

The green economy is being increasingly accepted by scholars as the modern-day concept which aims to develop the economy without damaging nature. Brown et al. (2023) argue that the green economy should not only fulfil the needs of humans but also those of the whole biosphere, the flowers and trees, and even the smallest insect. The primary component of this kind of model is economic policy, which promotes balanced development while guaranteeing the long-term maintenance of environmental variables. According to the Organization for Economic Co-operation and Development (OECD, 2024), the implementation of economic strategies that prioritize environmental sustainability and social fairness is in complete harmony with the principles of inclusive growth.

The Packet Policy, which also considers the green model, is increasingly being thought of as a realistic means for economic metamorphosis, especially in the context of the global financial crisis (Kim & Robinson, 2023). Green measures in the economic reforms would help in the process of structural changes that would concentrate on the efficiency of resources, investment in renewable energy and low-carbon industrialisation (World Bank, 2024). Thus the integration of greener guidelines will not only enhance the economic reforms but also make them

more aligned towards sustainable development objectives. Most studies have found that the countries which have embraced green growth principles have a more stable economy and are less vulnerable to external shocks (Gomez et al., 2023). Taylor and Ahmed note that the most appropriate definition of the green economy is that where human economic activity provides an operational connection to the ecosystem in terms of the processes involved in creating products and services (2024).

It belongs to one of the foundations of ecological economics development that aims at a balance between economic growth and environmental protection. In the case of developing countries, fertility improvements, green urbanisation, and the yet underdeveloped but ever-increasing renewable energy sector, just to name a few, are some of the areas in reference to green economy policies (FAO, 2024). These instruments enhance the economies and ensure that their growth will always be accompanied by environmental protection procedures.

Based on the fundamental tenets of the green economy, we shall be examining its effects on the chosen sustainable development goals (SDGs) in developing nations based on the following hypotheses:

• Hypothesis 1: The green economy is strengthened, which indicates the development of the economy. However, it usually means that green investments such as renewable energy and sustainable infrastructure are the main contributors to economic growth through the stimulation of innovation and the increase of resource efficiency. On the other hand, the opposing argument takes into consideration the fact that the very immediate cost of the green transition can be a major limitation and that probably the economies of low-income countries will not be able to carry such burdens due to the large restrictions (Chen & Gupta, 2024).

• Hypothesis 2: The green economy is strengthened, which means the coming of technological innovations and the industrial transformations. The direct benefits include the investments in green technologies that promote research and development and cover the whole range that goes from renewable energy to electric vehicles and to sustainable manufacturing, thus opening the door to all industrial advances along with the long-term competitiveness of the economy (Schneider & Patel, 2024). Nevertheless, some experts say that there will be quite good benefits from green technology soon, but the immediate situation will create a technological gap between the developed and developing countries, thus leading to economic inequalities and simultaneously depriving lower-income countries of their rights to participate in the green market (Ghosh & Lee, 2023).

• Hypothesis 3: The green economy is strengthened, which means the creation of higher employment. Green economic models would be the ones to generate new job opportunities, like renewable energy, sustainable construction, and waste management. It is also argued that the jobs created may require very specific skills which may not be available in developing economies, and hence, this might result in a mismatch between labour demand and supply (Miller & Torres, 2023).

Change has been noticed, not only because of their different yet common causes, but also because in these markets their options are so far less different. The economic model will hugely vary for each case of green economy development, e.g., transitioning to a green economy in Africa will not be anything like the one in Asia or Latin America. The Green Economy opens new and thrilling paths toward sustainability, but countless hurdles remain to be cleared for the complete process to take place, considering the socio-economic factors. One of the future research priorities will be how to turn green transition challenges into a win-win situation, especially in developing countries, where both the environment and economy will be positively impacted, and the less fortunate groups will be the ones that benefit.

Methodology and Data Sources

A cross-sectional dataset of 20 developing countries in 2024 is used in this research to analyse the correlation between the Green Economy (GE) and sustainable development outcomes. Among the countries covered in the study are Argentina, Brazil, Chile, China, Colombia, Egypt, Ethiopia, India, Indonesia, Iran, Kazakhstan, Mexico, Nigeria, Pakistan, the Philippines, Russia, Saudi Arabia, South Africa, Turkey, and Vietnam. The selection of countries was based on multiple criteria to guarantee an exhaustive and significant investigation. The foremost reason was that all the chosen countries had either a strong commitment to green economy initiatives or were in the process of the Green Economy transition. Secondly, the sample consisted of such a wide range of geographical and economic diversity that it ultimately increased the generalizability of our findings. Finally, only nations offering current and trustworthy data on all our key indicators from internationally recognised sources for the year 2024—the most recent year utilised in our study—were included in the selection.

Three sets of variables constitute the basis of our study, as seen in Table 2a and 2b below: control factors, Green Economy (GE) performance indicators, and Sustainable Development (SD) indicators.

Table 2a

Descriptions of variables

Variables	Symbols	Measurements	Data Source
Dependent variables			
GDP Per capita	GDP	GDP per capita (current US$)	WDI
Unemployment	UN	(% of the total labour force)	WDI
Technological Innovation	TEC	(% of the population)	WDI
Independent variables			
Climate Change	CC	GGEI	Dual citizen
Efficiency Sectors	ES	GGEI	Dual citizen
Investment	I	GGEI	Dual citizen
Environment	EN	GGEI	Dual citizen
Control Variables			
Labor Force	LF	Total labour force	WDI
Trade Openness	TR	Trade (% of GDP)	WDI
Carbon Emissions	CO2	CO2 emissions (kt)	International Energy Agency

Table 2b

Descriptive statistics

Variables	N	Min.	Max.	Mean	Std. Deviation
GDP	20	218.103	41035,721	4725.102	6271.010
UN	20	0.271	21,034	7.132	6.547
TEC	20	0.150	65,200	24.064	27.014
LF	20	0.087	801,340	41.348	127.163
TR	20	24.819	173,050	77.035	54.701
CO2	20	0,041	2,070	0,571	0,378
CC	20	0,428	1,107	1,024	0,471
ES	20	0,237	0,819	0,612	0,214
I	20	0,195	0,913	0,886	0,235
EN	20	0,204	0,784	0,615	0,228

Indicators of sustainable development (SD): These are our major dependent variables. Sustainable development is a complex and multi-dimensional phenomenon. To the benefit of this empirical investigation, though, we concentrate upon three critical macroeconomic indicators marking the social as well as economic face of sustainability and are frequently resorted to as proxies to monitor progress towards sustainable development.

GDP per capita: This is computed as an outcome of the World Bank database known as World Development Indicators (WDI), and it presents economic accomplishment and standards of living, the two key factors of sustainable development.

Total Unemployment (UN): This is the parameter that is also obtained through the WDI database, but is an important indicator of social sustainability as it shows the extent to which economic growth and labour market conditions are inclusive.

Technological Innovation (TEC): This is a complex measure of the WDI database that evaluates the ability of any country to innovate new technology that is vital in economic growth, as well as the ecological remedies.

Green Economy Indicator (GE). These are the main independent variables, which are based on the Global Green Economy Index (GGEI) in 2024. The GGEI is a composite index, and as such, we use it to assess the performance of a country in the green economy in four key aspects as individual indicators:

Climate Change (CC): Measures climate action, adaptation and mitigation measures.

Efficiency Sectors (ES): Measures the effectiveness of the resources in areas like waste management, water and energy.

Investment (I): Measures the green bond markets, green investment policies and green flows of finance.

The environment (EN) comprises ecosystem health, pollution control and biodiversity.

Control variables: We used several control variables, mostly drawn from the WDI database, to improve the robustness of our models and take into consideration other variables that might have an impact on our dependent variables.

The total labour force (LF), which represents the size of the workforce, gives unemployment rates context.

Trade Openness (TR): This indicator of a nation's level of economic integration with the rest of the world is expressed as a percentage of GDP.

CO2 Emissions (percentage of GDP): This variable, which comes from the International Energy Agency (IEA), shows how environmentally intensive economic activity is.

Model Specification

In the econometric analysis of this study, the Generalised Least Squares (GLS) regression model was utilised. It was decided to employ GLS at first due to its greater effectiveness than OLS in dealing with the problem of possible heteroskedasticity, which is the case with cross-

sectional datasets where error variance is not constant across the observations. In this way, we obtain parameter estimates with greater precision and effectiveness. The cross-sectional nature of our 2024 data and the lack of uniform time-series data for the Global Green Economy Index also support the use of GLS. Our regression equation takes the following generic form:

$$SD_i=\beta_0+\beta_1 GE_{i,ClimateChange}+\beta_2 GE_{i,EfficiencySectors}+\beta_3 GE_{i,Investment}+\beta_4 GE_{i,Environment}+\beta_5 ControlVariables_i+\epsilon_i \quad (1)$$

SD_i: Represents the sustainable development indicators (GDP per capita, unemployment rate, or technological innovation) for country i.

$GE_{i,j}$: Represents the scores of country i across the four dimensions (j) of the Global Green Economy Index.

Control Variables: Represents the set of control variables (Trade as % of GDP, Total Labour Force, CO_2 Emissions as % of GDP) for country i.

β_0: Intercept term.

β_1 to β_5: Coefficients representing the impact of each independent variable on the dependent variable.

ϵ_i: Error term for country i.

To further reduce the heterogeneity and ensure that our variables conformed to the assumptions of the model, we performed a logarithmic transformation on the dataset. This transformation not only stabilises the variance and reduces the effect of outliers but also assists in linearising relationships.

Sub-Models:

1. Economic Progress (GDP per capita):

$$LGDP_i=\alpha+\beta_1 GE_{i,ClimateChange}+\beta_2 GE_{i,EfficiencySectors}+\beta_3 GE_{i,Investment}+\beta_4 GE_{i,Environment}+\beta_5 ControlVariables_i+\epsilon_i \quad (1)$$

$$(2)$$

2. Job Creation (Unemployment Rate):

$$LUN_i=\alpha+\beta_1 GE_{i,ClimateChange}+\beta_2 GE_{i,EfficiencySectors}+\beta_3 GE_{i,Investment}+\beta_4 GE_{i,Environment}+\beta_5 ControlVariables_i+\epsilon_i \quad (1)$$

$$(3)$$

3. Technological Innovation and Industrial Transformation:

$$LTEC_i=\alpha+\beta_1 GE_{i,ClimateChange}+\beta_2 GE_{i,EfficiencySectors}+\beta_3 GE_{i,Investment}+\beta_4 GE_{i,Environment}+\beta_5 ControlVariables_i+\epsilon_i \quad (1)$$

$$(4)$$

Heteroskedasticity, which consists of a variety of models used for estimation, is usually a classical assumption violated for most cross-sections. Therefore, the present study applies the following strategies to tackle heteroskedasticity:

a. Check for robustness: The insignificant variables are eliminated, and the model is reestimated to check its robustness.

b. Ramsey RESET test: Model misspecification is tested and corrected with the help of this test, which can consequently produce impure heteroskedasticity.

c. Income-level categorisation: Developing countries are categorised based on income levels, namely low-income, upper-middle-income, and high-income, based on the World Bank classification. A dummy variable is now introduced such that

Di = 1 if an upper-middle-income country.

Di = 0, otherwise.

This categorisation controls income-related heterogeneity and allows the estimation of the effect of the green economy on sustainable development, labour market outcomes, and technological innovation to be as accurate as possible.

Empirical Results

The initial step of the analysis is to use descriptive statistics and a correlation matrix to study the dataset's key characteristics and the relationships among the variables.

Descriptive statistics and correlation analysis

Descriptive statistics indicate that there is considerable variation among the 20 developing countries included in our sample. The vast range and the considerable standard deviation of GDP per capita ($218,103 to $41,035,721) serve to illustrate the pronounced economic inequalities in our sample. A wide diversity of labour market systems and participation rates is also indicated by the labour force

variable's notable fluctuation. Together, these variations demonstrate that our sample is appropriate for a thorough examination of the complex relationships among social issues, environmental effects, and economic expansion.

The correlation matrix provides initial information about how our variables interact. The significant inverse relationship between carbon emissions and climate change (-0.7349) is one of the most startling results. This contradictory finding appears to suggest that the most impacted nations are either reducing their industrial activity or enforcing more stringent emission-reduction laws, which is what is creating the negative association.

GDP per capita using regression analysis

The regression results of GDP per capita (L(the) with a coefficient of determination value of 0.8219 indicate a very good overall model fit. This is a powerful finding for cross-sectional data, meaning our independent variables nearly explain 82% of the change in GDP variation.

Environment (LEN) and climate change (LCC) present significant and positive coefficients. This means that countries with strong environmental laws and active participation in climate change can reap economic benefits. Among the reasons for this are the increase in the use of resources, the gaining of investments that are eco-friendly, and the fostering of new markets for green technologies. Even though their statistical significance is quite low in this model, the efficiency sectors (LES) and the investment (LI) show positive coefficients, implying that these areas' advancements are factors contributing to GDP growth.

Table 3.
Correlation Matrix

Variables	CC	ES	I	EN	LF	TR	CO2
CC	1						
ES	0,03478	1					
I	-0.2943	0.5129	1				
EN	-0.6178	0.1682	0.4136	1			
LF	-0.3045	0.4367	0.3762	0.0577	1		
TR	-0.1937	-0.2184	-0.0617	0.1874	-0,2671	1	
CO2	-0.7349	-0.0946	0.1751	0.2138	0.3159	0.4328	1

CC: Climate change, ES: Efficiency Sectors, I: Investment, EN: Environment, LF: Labour Force, TR: Trade Openness, CO_2: CO_2 Emissions

The coefficient of the labour force (LLF) variable is large and negative, as indicated in Table 3. This finding is very interesting and complicated at the same time. A bigger labour force does not have to be a factor that pushes GDP down. It may indicate the opposite: unskilled, idle, or inefficient labourers in these markets. The situation of many workers in developing countries who lack the

necessary skills for a transition to a green economy may be the reason for declining overall productivity and, consequently, their inability to contribute to GDP growth.

Analysis of Regression: Rate of Unemployment

The model for the unemployment rate (L(UN)) showed a good fit as evidenced by the R-squared of 0.4278, as indicated in Table 4. The environment (LEN) variable's coefficient is positive but not statistically significant. The weak correlation underlines the scenario where the imposition of strict environmental regulations may one way or another, cause the non-renewable energy sectors to lose employees. Some high-polluting corporations might reduce their operations or become completely out of business if the governments introduce new laws about the environment, thus the workers are laid off temporarily. This underlines the importance of just transition policies in alleviating the negative social impacts of the green economic changes.

Table 4.

Result of the Analysis

L (GDP) Dep. variable	Coef.	Std. Err.	t-test	P> |t|	[95% Conf. Interval]	VIF Ext.
Constant	3.178	0.614	6.41	0.000***	4.1020	
LCC	1.453	0.519	3.18	0.018**	0.3150	1.8700
LES	0.814	0.378	1.83	0.061*	1.6470	1.6200
LI	0.572	0.346	1.77	0.143*	1.3250	1.8300
LEN	0.001	0.314	6.42	0.000***	2.7490	1.7600
LTR	-0.0016	0.276	-0.02	0.914	1.9460	1.5500
LLF	-0.1294	0.138	-2.19	0.017*	0.0020	1.8200
LCO2	-0,0027	0,051	-0.01	0.948	0.1980	2.0300

Num. of obs = 20 F (5. 93) = 17.58 prob> F = 0.0000
R-Sq. = 0.8219
Adj.R-Sq = 0.8073
Br.P. = 0.647
Sh.W. = 0.825

Note: * Significant at 10%; ** Significant at 5%; *** Significant at 1%.
CC: Climate change, ES: Efficiency Sectors, I: Investment, EN: Environment, LF: Labour Force, TR: Trade Openness, CO_2: CO_2 Emissions

Regression Analysis: Innovation in Technology

The technological innovation model (L(TEC)), supported by an R-square of 0.8314, is considered a perfect fit for the data, as stated in Table 5. The coefficient of investment (LI) is negative and very significant. This finding is surprising and requires further inquiry. It may not be the case that investment impedes innovation, but rather that a significant portion of investment in these underdeveloped countries is directed towards traditional, low-innovation

industries, or that poor R&D infrastructure and lack of complementary policies make it hard for investment to successfully convert into technological progress.

Table 5.

Result of the Analysis

L (UN) Dep. variable	Coef.	Std. Err.	t-test	P> |t|	[95% Conf. Interval]	VIF Ext.
Constant	1.945	0.691	3.17	0.023***	3.7840	
LCC	0.8149	0.588	-1.81	0.218*	0.3190	1.9700
LES	0.041	0.435	-0.97	0.412	1.5520	1.6400
LI	0.512	0.417	-1.09	0.248	1.4180	1.7900
LEN	0.643	0.309	2.34	0.057**	1.5370	1.6100
LTR	-0.218	0.276	-1.12	0.361	0.3750	1.7800
LLF	-0.137	0.105	-2.28	0.019**	-0.0430	1.8300
LCO2	-0.054	0.174	-0.25	0.872	0.4060	2.0700

Num. of obs = 20 F (6.81) = 3.97 prob> F = 0.0000

R-Sq. = 0.4278

Adj.R-Sq = 0.3951

Br.P. = 0.2197

Sh.W. = 0.2674

Note: * Significant at 10%; ** Significant at 5%; *** Significant at 1%.
CC: Climate change, ES: Efficiency Sectors, I: Investment, EN: Environment, LF: Labour Force, TR: Trade Openness, CO2: CO2 Emissions

There is a marginally significant positive value for the environment (LEN) coefficient, see table 6 below. This implies that an emphasis on environmental quality can partially stimulate the development of new, green technologies, even though environmental regulations by themselves might not be a major source of innovation.

In this case, trade openness (LTR) or carbon emissions (LCO2) do not seem to be associated with technical innovation. This implies that in the absence of intentional, focused governmental activities, exposure to foreign countries or the existence of environmental externalities alone are insufficient to promote innovation.

Table 6.

Result of the Analysis

L (TEC) Dep. variable	Coef.	Std. Err.	t-test	P> |t|	[95% Conf. Interval]	VIF Ext.
Constant	-0.945	1.691	-0.59	0.915*	2.9470	
LCC	0.8149	1.588	0.75	0.872*	3.1240	1.3800
LES	0.041	1.435	-0.47	0.468	2.7410	2.9400
LI	-0.197	1.417	-2.63	0.004**	-1.1240	3.4700
LEN	2.415	1.309	1.95	0.072**	-0.9780	1.6100
LTR	0.379	1.276	0.91	0.793	0.3970	5.2400
LLF	0.438	1.105	1.52	0.197*	0.5470	3.1800
LCO2	-0.648	1.174	-0.68	0.426	0.4750	2.3600

Num. of obs = 20 F (7.13) = 14.82 prob > F = 0.0000

R-Sq. = 0.8314

Adj.R-Sq = 0.8127

Br.P. = 0.3146

Sh.W. = 0.7195

Note: * Significant at 10%; ** Significant at 5%; *** Significant at 1%.
CC: Climate change, ES: Efficiency Sectors, I: Investment, EN: Environment, LF: Labour Force, TR: Trade Openness, CO2: CO2 Emissions

Our econometric models' results offer important insights into the intricate connections between a nation's macroeconomic results and the performance of its green economy. Our findings demonstrate that although a green transition may promote innovation and economic growth, these benefits are not always evident.

Conclusion

The article gives an in-depth analysis of the complex relationship between macroeconomic information and the concept of the green economy in an array of tools, including regression analysis, correlation, and descriptive statistics. The paper examines the effect of climate change, environmental quality, economic efficiency, investment, labour market dynamics, trade openness and carbon emissions on key indicators, such as GDP and unemployment. The results suggest that a sustainable future is a complicated matter that requires the realisation of economic, social and environmental objectives in a harmonious and balanced way. The results of the regression analysis show that green investments and environmental quality have a positive and significant influence on the per capita GDP.

The specified result demonstrates that economic and environmental objectives do not necessarily clash in the course of green transformation. Green investments can enhance the environment as well as economic growth through clean technologies and economic strategies that are geared towards sustainability. Nonetheless, the negative effect of the labour force variable on the GDP in the model implies that any of the lack of co-existing skills,

underemployment and inefficiencies in the labour market are possibilities.

In this case, we can state that the shift to the green policies will not always lead to the creation of jobs; vice versa, this process should be supported by the supply of the labour force with the proper skills and education. Quite the contrary, the unemployment model demonstrates the fact that the labour force increase causes the decline of the unemployment rate. This phenomenon identifies the possibility of creating jobs and involvement of the labour force.

Nevertheless, the existence of the positive correlation between unemployment and the quality of the environment indicates the potential that tighter environmental regulation need not be a good thing for the economy and the environment. It also offers strong evidence of the theory that the revamping of green economic policies would involve the transfer of workers in high-emitting industries and programmes to re-skill them to accommodate them. On the other hand, the minor influence of investment, productivity, climate change and carbon emissions on unemployment implies that structural factors in the labour market must be tackled by the interventions, which are both specific and wide-ranging economic and environmental policies.

An analysis of the connection between macroeconomic variables and technological changes will become an important component of the research. The analysis shows that the investment and productivity sectors are relevant sources of innovation; however, trade liberalisation and technological progress have not been connected. The observation gives credence to the fact that international trade should be used along with other strategies (such as R&D investment) to drive innovation. Furthermore, it can be seen that the results of the discovery of the carbon emission impact being neutral on innovation indicate that the environmental externalities cannot by themselves promote the technology. The findings also suggest that governments adopt a multidimensional approach to the process of integrating economic, social and environmental objectives.

Policy Recommendation

Promoting Green Investments for Sustainable Growth: Our research shows how investments and environmental quality significantly boost a nation's GDP. Therefore, it is necessary to promote investments in areas such as green industries, eco-friendly technologies, and renewable

energy. Public-private partnerships, tax advantages, and green financing strategies can guarantee economic growth in line with sustainability objectives.

Employment-Oriented and Just Green Transition: Targeted policies must be put in place to facilitate the green transition and prevent any potential negative effects on employment because of the inefficiencies in the labour market. Priority should be given to skill development and vocational training that enable workers to transition from high-emission industries into new green jobs. This will improve economic productivity and include marginalised people in the economy in addition to resolving the issue of skills mismatch in the job market.

Promoting Innovation by Means of Targeted Policies: According to our research, commerce and innovation are not as closely related as the productivity and investment sectors. To foster an atmosphere that is favourable to technological innovation, establish solid university-industry partnerships, and provide adequate protection for intellectual property rights, policymakers should provide targeted R&D grants. One key step in accelerating technological advancement is to integrate digitisation initiatives with the national economic agenda.

Environmental Effects of International Trade: Trade liberalisation and the amount of carbon emissions were found to be positively correlated. This suggests that future international trade will be supported by the need for sustainable trade policy.

Eco-friendly logistics and transportation technologies will be the main ways to reduce the trade-off between international trade and the environment. In fact, the recommendations lead to strategies that prioritise sustainable trade rules, labour market reforms, green investments, and innovative policies as the key to economic resilience. The policies aimed to address environmental degradation and climate change while ensuring sustainable and equitable economic growth.

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Genişletilmiş Özet

Çalışmanın metodolojisi, 2024 yılına ait 20 gelişmekte olan ülkeden elde edilen kesitsel verilerle sürdürülebilir kalkınma ve yeşil ekonomi arasındaki karmaşık ilişkiyi incelemektedir. Bu ilişki, mimari planlama ve kentsel ekonomik canlılık açısından önemli sonuçlar doğurmaktadır. Çalışmada sürdürülebilir kalkınma (SD) üç temel göstergeyle tanımlanmaktadır: ekonomik performansı yansıtan kişi başına GSYİH, işgücü piyasası dinamiklerini gösteren toplam işsizlik oranı ve bir ülkenin ileri ekonomik faaliyetler ile potansiyel yeşil mimari çözümler için kapasitesini belirten teknolojik inovasyon.

Yeşil ekonomiyi (GE) değerlendirmek için ise Küresel Yeşil Ekonomi Endeksi (GGEI) kullanılmaktadır. Bu endeks; iklim değişikliği, verimlilik sektörleri, yatırım ve çevre gibi faktörleri içerir. Modele eklenen kontrol değişkenleri (ticaretin açıklığı, işgücü büyüklüğü ve CO2 emisyonları) ise ulusal ekonomi politikaları ile kentleşmenin çevresel etkilerini daha incelikli bir şekilde ayrıştırmayı sağlamaktadır.

Tanımlayıcı istatistikler, 20 gelişmekte olan ülke arasında dikkate değer ekonomik farklılıklar olduğunu ortaya koyarak, yeşil ekonomiye geçiş için çeşitli başlangıç noktalarına işaret etmektedir. İşgücü büyüklüğü ve kişi başına GSYİH'deki (218 dolardan 41.035 dolara) geniş fark, farklı ekonomik ölçekleri ve gelişme aşamalarını açıkça göstermektedir. Bu çeşitlilik nedeniyle, yeşil ekonomiye geçişin getireceği ekonomik avantajlar ve zorluklar (örneğin istihdam yaratma, endüstrilerin dönüşümü ve yeşil yatırımlarla ilgili maliyetler) bu ülkelerde farklı şekillerde kendini gösterecektir.

Korelasyon matrisi, Yeşil Ekonomi (GE) boyutları ile makroekonomik göstergeler arasında önemli ve anlamlı ilişkiler olduğunu vurgulamaktadır. Örneğin, ticaretin açıklığı ile CO2 emisyonları arasında pozitif bir korelasyon gözlemlenmiştir. Bu bulgu, ekonomik entegrasyonun özellikle kentsel sanayi bölgelerinde sorumlu bir şekilde yönetilmezse çevresel etkileri kötüleştirebileceğini göstermektedir. Ayrıca, modelin güvenilirliği için yapılan analizde çoklu doğrusal bağlantı kanıtı bulunmadığı doğrulanmıştır. Bu sonuçlar, modelin analiz için uygun olduğunu ve elde edilen bulguların sağlam olduğunu teyit etmektedir.

Ampirik bulgular, ekonomik sonuçların yeşil ekonomi unsurlarından nasıl etkilendiğine dair değerli bilgiler sunmaktadır. Kişi başına GSYİH regresyonunun güçlü R-kare değeri (0.8219), yeşil ekonomi unsurlarının ekonomik performansın önemli bir bölümünü açıkladığını gösteriyor. GSYİH ile iklim değişikliği (LCC) arasında pozitif ve güçlü bir ilişki, iklim direncine yönelik altyapı ve mimariye yapılan yatırımların ekonomik büyümeyi teşvik edebileceğini gösteriyor. Ayrıca, çevre kalitesi (LEN) GSYİH üzerinde büyük ve olumlu bir etkiye sahiptir, bu da yeşil bina ve kentsel planlama faaliyetlerinin finansal avantajlarını vurgulamaktadır.

Yatırımın (LI) teknolojik inovasyonla (L(TEC)) negatif korelasyon içinde olması, sezgilere aykırı bir bulgu olmakla birlikte mimari açıdan çok önemlidir. Bu durum, yatırımların ya yanlış tahsis edildiğini ya da belirli gelişmekte olan ekonomilerde sürdürülebilir kentsel gelişmeyi teşvik edebilecek yüksek teknolojili, yeşil bina inovasyonlarına yönlendirilmediğini gösteriyor. Bu bulgular, sürdürülebilir bina ve kentsel planlama alanındaki teknolojik gelişmeleri destekleyen odaklanmış yeşil harcamaların gerekliliğini vurgulamaktadır.