International Journal of Economics and Finance; Vol. 16, No. 11; 2024
ISSN 1916-971X E-ISSN 1916-9728
Published by Canadian Center of Science and Education

Green Economy and Sustainable Economic Growth: An Econometric Study Using the Panel Data Model during the Period (1998-2022)

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Received: July 6, 2024 Accepted: October 8, 2024 Online Published: October 31, 2024

doi:10.5539/ijef.v16n11p106 URL: https://doi.org/10.5539/ijef.v16n11p106

Abstract

The study aimed to measure the impact of the green economy on economic growth in some countries during the period (1998-2022) using a Panel Data model to measure the relationship between economic growth, expressed by Gross Domestic Product as a dependent variable, and green economy indicators as independent variables. The study sample consisted of five countries: Saudi Arabia, the United Arab Emirates, Malaysia, Singapore, and Sweden. Data were estimated using three models: the pooled regression model, fixed effects, and random effects. The results indicated that the fixed effects model was the most appropriate for this study. Using the statistical program EViews, the study found, as expected, a negative relationship between renewable energy consumption and Gross Domestic Product. Contrary to expectations, the study found an inverse relationship between carbon dioxide emissions and Gross Domestic Product. The study also found no significant effect of economic growth on both the value-added in the agricultural sector and the individual share of freshwater resources.

Keywords: green economy, global green economy index, sustainable development, environmental performance index

1. Introduction

Gross Domestic Product (GDP) growth is one of the most important indicators of economic prosperity for countries, whether contributed by the public sector, the private sector, or both. However, this growth may have negative aspects - in addition to the positive ones - especially if achieved at the expense of the environmental side, by depleting natural resources without allowing for their renewal (Zaidan, 2022). In the environmental context, data from the World Health Organization (WHO) have shown that pollution of individuals' surroundings - especially children under the age of five and the elderly (75-50 years old) - and exposure to chemicals have made them breathe polluted air, leading to an increase in the number of deaths to reach 450,000 annually in 2016 (World Health Organization, 2016). This number has increased to approximately 7 million annually in 2018 (World Health Organization, 2018). In 2022, the world's population reached eight billion people, all of whom are competing unfairly for environmental resources (Bukdi, 2019). United Nations estimates also project the global population to reach 9.7 billion by 2050 (UNFPA, 2009). Additionally, climate change has resulted in significant economic losses worldwide, peaking in 2017 at an estimated $337 billion. This is alongside the phenomena of global warming and climate change, originating from the burning of fossil fuels (Al-Gubashi, 2019).

Recently, many modern terms have emerged in the global economy focusing on the economic aspect without harming the environmental aspect, to adopt the latest strategies to provide a clean economy focused on renewable energy, which is one of the most important sources of the green economy (Belhassen & Sheikh, 2022). For example, many terms have emerged - apart from the brown economy - such as the term Green Economy, which focuses on forests and their resources, among other terms. Indeed, the United Nations Environment Programme (UNEP, 2011) launched a new path called the Green Economy Initiative after the global economic crisis (2008), aiming to transform the world's economies into green economies, increase efficiency in resource use, and reduce deterioration in the ecosystem, achieving optimal returns on investment in various economic, environmental, and human resources, in addition to encouraging and stimulating private sector projects that focus on the environment and its renewable resources, organic agriculture, waste management, and sustainable consumption. This works to increase the growth rate in GDP and reduce poverty and unemployment rates in the

country.

The green economy aims to reduce the carbon emissions rate and other harmful gases (Tuwat et al., 2019). Additionally, it aims to provide safe drinking water, leading to a decrease in the mortality rate associated with inadequate water treatment systems (World Health Organization, 2016). In this context, it is worthwhile to address green bonds as one of the positive initiatives towards transitioning to a green economy. The World Bank has estimated that more than $13 billion has been raised through these bonds, with the amount increasing to $15.4 billion by the end of 2018. Of this, $8.5 billion was allocated to support projects in 28 countries, while the remaining $6.8 billion has yet to be allocated. Moreover, more than half (69%) of the green bonds are directed toward renewable energy projects, energy efficiency, and clean transportation (Al-Gubashi, 2019).

Statistics from the fifth edition (2016) of the Global Green Economy Index (GGEI) showed Sweden's performance ranking first among the eighty countries, indicating the efficiency of green investments there. Conversely, the statistics highlighted the decline in Malaysia's performance, which was among the top ten, indicating a decline in green investments and thus the need to support sustainable practices there. At the level of the Gulf Cooperation Council (GCC) countries, the UAE has made progress, maintaining its performance level and ranking 45th among the eighty countries. In Saudi Arabia, despite the lack of clear initiatives toward the green economy until 2016, Vision 2030 represents one of the first and most important initiatives toward such an economy, focusing on economic diversification and reducing reliance on the oil sector (Dual Citizen LLC, 2016).

Therefore, the shift towards the green economy has become an urgent necessity, as it balances financial resources with environmental resources and achieves a positive impact on the economic, social, and environmental aspects. All these aspects contribute to achieving sustainable development, thereby promoting social justice and economic welfare. Many studies have discussed the extent to which economic growth is affected by the green economy, through various key indicators measuring the impact of this type of economy on the Gross Domestic Product growth rate, such as leadership and climate, sectoral efficiency, green markets, and investments, environment, and natural capital (Abu Alayan, 2017). Thus, this study aims to analyze the impact of green economy indicators on economic growth in some countries, namely Saudi Arabia, the United Arab Emirates, Malaysia, Singapore, and Sweden, during the period from 1998 to 2022. To achieve this goal, the study relied on the Panel Data methodology using the statistical software EViews.

1.1 Study Problem

The green economy has always had a positive impact on economic growth rates (Abdelhamid, 2022) and individuals' share of the Gross Domestic Product (Abu Alayan, 2017). It works to reduce the spread of poverty (Lukas, 2015) and improve the living standards of society members (Radi, 2021), in addition to many positive goals that various countries aspire to achieve. It serves as an incentive to achieve sustainable economic growth, which requires conducting more studies in the context of the green economy and increasing levels of environmental awareness. This is particularly important as the green economy is a modern concept at various levels - economic, social, and environmental - including the subject of the current study, which relates to the impact of the green economy on economic growth in some countries during the period (2022-1998).

1.2 Study Objectives and Questions

Recognizing the importance of researching the impact of the green economy on economic growth rates, the researchers aim to shed light on the concept of the green economy, its significance, in addition to the impact of some indicators of this economy on economic growth in the countries under study, namely: Saudi Arabia, the United Arab Emirates, Malaysia, Singapore, and Sweden. Accordingly, the main objective of this study is to analyze the impact of the green economy on economic growth in some countries, as a standard study using the Panel Data model, during the period (2022-1998). The research problem can be formulated in the following question:

What is the impact of green economy indicators on economic growth rates?

1.3 Study Importance

The selection of countries in the study—Saudi Arabia, the United Arab Emirates, Malaysia, Singapore, and Sweden—reflects their varied approaches to green economy practices and differing levels of economic development, enabling a comparative analysis of green economy indicators' impact on economic growth across diverse contexts. Saudi Arabia and the UAE, as Gulf Cooperation Council (GCC) countries, demonstrate a strong commitment to sustainable development through initiatives like Saudi Arabia's Vision 2030 and the UAE's "Green Economy for Sustainable Development," showcasing efforts by oil-rich nations to diversify their

economies. In Southeast Asia, Malaysia and Singapore offer contrasting strategies, with Malaysia's focus on agriculture and Singapore's emphasis on urban sustainability, providing a regional comparison of green economy practices. Sweden, renowned for its leadership in sustainable policies and high ranking in global green economy indexes, represents a mature approach to green economy initiatives, illustrating the benefits of well-established policies. Together, these countries offer a mix of Arab and non-Arab, oil-dependent and diversified economies, allowing the study to explore the applicability of green economy measures across various economic and environmental contexts.

Moreover, the green economy is a relatively recent branch of economics that has emerged worldwide as one of the most important implications necessitated by the need for sustainable development, away from any environmental risks. This has brought forth challenges in driving forward green industries and their development, transitioning towards a low-carbon economy. Therefore, the importance of the current study stems from the significance of transitioning to such an economy, making it not only beneficial for the current generations but also for those to come in the future. Accordingly, the focus will be on the reality of the green economy in some countries - the subject of the study - and its implications for economic growth therein.

2. Literature Review

Due to the significant trend toward a green economy and increasing environmental awareness, many researchers have focused on studying this economy and its impact on economic growth in various countries around the world. It has become necessary to rely on clean energy by adopting the concept of the green economy, as it has a huge impact on reducing the prices of local goods, and therefore on improving the overall standard of living. This is what Rady concluded, in his study (2021) titled "The Green Economy as a Strategic Option for Sustainable Development in the Iraqi Economy," where the researcher used the experimental method in addition to the descriptive analytical method. Also, Rady added that adopting the green economy in Iraq will help to improve relations with neighboring countries through establishing partnerships in this area. Therefore, the researcher recommended the necessity of encouraging researchers and specialized research centers to focus on the field of clean energy instead of traditional energy, which has a negative impact on environmental cleanliness.

Despite the positive impact of the Global Green Economy Index on Gross Domestic Product (Abu Alayan, 2017), the opposite is not true, as Gross Domestic Product does not take into account resource depletion and its environmental impact (Vaghefi et al., 2015). Therefore, it was necessary to increase attention to Green Gross Domestic Product, which considers the costs of these environmental processes. We will now outline some of the most important positive effects of adopting the concept of the green economy in some countries, as follow

2.1 Advantages of Adopting a Green Economy

2.1.1 Green Economy and Sustainable Development

Economic growth is considered one of the most important quantitative determinants of sustainable development (Rashid, 2013). The main goal of the green economy is to achieve sustainable development and confront climate change (Zaidan, 2022). In general, there is an overlap between the concepts of the green economy and sustainable development, where renewable energy projects support the green economy, which in turn supports the process of achieving sustainable development. Renewable energy is also considered the most important source of the green economy. This was concluded by Belhassen and Sheikh's study (2022), titled "The Role of the Green Economy in Achieving Sustainable Development," using both descriptive and analytical methodologies. In the context of this overlap between the two concepts, the researchers found that both adopt the same goals, such as eradicating hunger and promoting good health, and well-being. The researchers recommended the necessity of increasing incentives toward transitioning to a green economy in various Arab countries.

Based on the foregoing, the green economy plays a role in achieving sustainable development, as it is considered one of the mechanisms for achieving it, and it has a positive impact on economic growth. This was the conclusion of Abdulhamid's study (2022), titled "The Green Economy and Its Role in Achieving Sustainable Development," using a cross-sectional data model for 110 countries during the year 2018. Therefore, the researcher recommended the necessity of encouraging such investments - whether public or private - that increase energy efficiency rates and reduce rates of environmental degradation and carbon dioxide emissions.

Similarly, Zaidan's study (2022), titled "Implications of the Green Economy on Economic Growth in Egypt (A Comparative Study - A Standard Model)," affirmed the presence of a significant relationship between transitioning to a green economy and economic growth during the period (2000-2021). This was done using both the inductive method to benefit from the experiences of a group of Arab and Western countries, and the standard

method to interpret the relationship between the green economy and economic growth in the Republic of Egypt. Zaidan recommended the necessity of using modern methods to rationalize water consumption and improve irrigation networks and the quality of agricultural cultivation, in addition to finding a solution to the problem of agricultural waste and how to utilize it.

The study conducted by Abu Alayan (2017), titled "Green Economy and Sustainable Development in Palestine: Proposed Strategies," concluded the positive impact of the Global Green Economy Index (GGEI) with its three dimensions on individual shares of Gross Domestic Product (GDP). This was achieved using both descriptive analytical methodology and standard methodology to analyze the experiences of advanced countries in the field of the green economy and its impact on economic growth rates and unemployment, and thereby clarifying the impact of this economy on developing countries. The researcher relied on a cross-sectional data model for 80 countries - both advanced and developing - for the year 2015, in building simple and multiple regression models using the Stata program. Consequently, the study recommended the adoption of the green economy in Palestinian territories.

In contrast to the previous findings, Lukas (2015) in his study titled "Green Economy for Sustainable Development and Poverty Alleviation" found a negative impact of the Global Green Economy Index (GGEI) on the Gross Domestic Product (GDP) growth rate, using the standard methodology applied to 60 countries. However, the same study concluded the positive impact of the same index on increasing individual income and reducing poverty. Therefore, the study recommended the necessity of all sectors of the state - whether private or public - contributing to support and finance green economy investments, aiming to reduce poverty levels and achieve sustainable development.

Despite the necessity of financial institutions' participation in financing the green economy, it is challenging to determine the optimal mechanism for financing this economy in a given country without taking all aspects - economic, political, environmental, industrial, and social - into consideration. Therefore, environmental financing has become one of the most prominent issues that governments and relevant entities are focusing their efforts on, to protect their environmental resources and create a balance between the needs of current and future generations (Musharri, 2019).

2.1.2 Green Economy and Food Security

Considering that food security is a fundamental axis for achieving economic growth and sustainable development, although the transition to organic farming methods may contribute to achieving the goal of food security in the medium and long term, the costs of transitioning to the green economy outweigh its benefits. This is what Mustafa's study (2021) in East Africa, titled "Activating the Contribution of the Green Economy to Achieving Sustainable Development and Food Security: An Applied Study with a Focus on Egypt," concluded using analytical and inductive methodology, and relying on the SWOT Analysis approach. The researcher recommended the necessity of identifying the best methods, laws, and regulations to increase agricultural production and ensure environmental compliance processes.

Contrary to the aforementioned, the green economy may have a negative impact on food security, as concluded by Kinda's experimental study (2021) titled "Does the Green Economy Enhance Food Security in Sub-Saharan Africa?" which measured the impact of the green economy on food security in 35 countries during the period (2001-2015) using fixed effects estimator and two-step GMM system models. The study found a negative impact of biofuel production on food security, as its production increases competition for labor, land, and water resources, thus shifting focus from food production to biofuel production. Additionally, the study found no impact of decreasing carbon dioxide emissions on food security

2.1.3 Green Economy and Unemployment

In general, Gross Domestic Product (GDP) operations, investments, and technological innovations contribute to the growth and development of the labor market by reducing unemployment rates in the long run (LR) (Naqvi et al., 2021). Green jobs are considered one of the solutions to unemployment, in addition to the impact of this type of employment on both the Environmental Goods and Services Sector (EGSS) and Gross Domestic Product (GDP). This was confirmed by the study conducted by Sulich and Rutkowska (2019), titled "Green Jobs as a Solution to Unemployment." Zaidan's study (2022) also emphasized that increasing the share of green sectors in the economy will lead to an increase in the number of green jobs, with the number of innovative projects in the green economy sector in the Republic of Egypt reaching 579 projects, indicating an increase in employment opportunities in that field. Many researchers have emphasized that to ensure the balance between the green economy and green jobs, decision-makers must continue to promote various areas of the green economy, such as solar photovoltaic technologies, biomass, and wind energy. This was concluded by the study conducted by Cai et

al. (2011) titled "Green Economy and Green Jobs: Fact or Myth? Case Study of the Energy Generation Sector in China," during the period (2006-2009). The study found that although reducing greenhouse gases in the energy generation sector led to the loss of 44,000 jobs in China, increasing the share of renewable energy overall led to an increase in the number of jobs to 472,000 jobs in 2010. Each increase in the share of solar photovoltaic energy generation by 1% corresponded to a 0.68% increase in total employment in China. This indicates that this percentage represents the largest increase for any other technology used in energy generation.

Contrary to the above, some studies have indicated a lack of a clear relationship between the Global Green Economy Index and unemployment rates, such as the study by Abu Alayan (2017) and Lukas (2015). Additionally, Apergis and Salim's study (2015) titled "Renewable Energy Consumption and Unemployment: Evidence from a Sample of 80 Countries and Non-linear Estimates" during the period (1990-2013) found that despite the positive impact of renewable energy consumption on unemployment, this impact is not universally applicable, as the relationship between these variables is influenced by both the efficiency of renewable energy and the cost of adopting such energy technologies, which varies across regions. The study concluded that in some regions like Asia and Latin America, there was a negative effect of renewable energy consumption on unemployment. In the same context, Naqvi et al.'s study (2021) titled "Towards a Green Economy in Europe: Does Renewable Energy Production Have Asymmetric Effects on Unemployment?" found that the operations of Gross Domestic Product, investments, and technological innovations do not significantly contribute to the growth and development of the labor market and the reduction of unemployment rates in the short run.

2.2 The Green Economy in the Studied Countries

2.2.1 Green Economy in Saudi Arabia

Since the beginning, the Kingdom has participated in the introduction and discussion of the seventeen Sustainable Development Goals at the United Nations Summit (2015) by the member states of the United Nations. The Kingdom has also made these goals a top priority, assigning the Minister of Economy and Planning to ensure their achievement. These goals align with the Kingdom's Vision 2030 (2016), which revolves around three core pillars: "A Thriving Nation, Vibrant Society, and Prosperous Economy" (First Voluntary National Review, 2018). Recently, there has been an increasing interest in the green economy and sustainable development in the Kingdom. This is evident through numerous initiatives aimed at overall environmental development. The following figure (Figure 1) illustrates some of the key aspects supporting the transition to a green economy in the Kingdom, as follows:

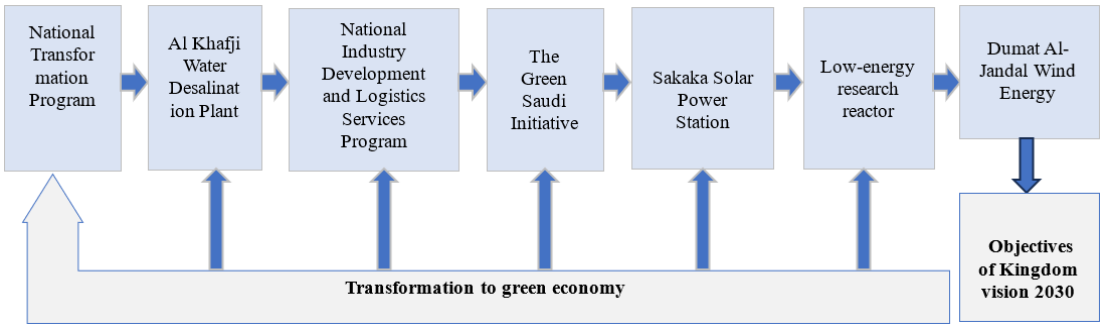

Figure 1. Initiatives for transitioning to the green economy in Saudi Arabia

Source: Compiled by the researchers, based on the official website of Saudi Vision 2030.

In general, the Kingdom is striving diligently to develop the renewable energy sector, aiming to reach optimal production levels, committing to reducing environmentally harmful emissions, such as carbon dioxide (CO2) emissions, ultimately achieving net zero emissions by 2050. Indeed, the rates of these emissions have decreased during the period following the Kingdom's 2030 Vision (Qasim et al., 2023). Based on World Bank data, the following figure (Figure 2) confirms the decrease in CO2 emission rates in the Kingdom:

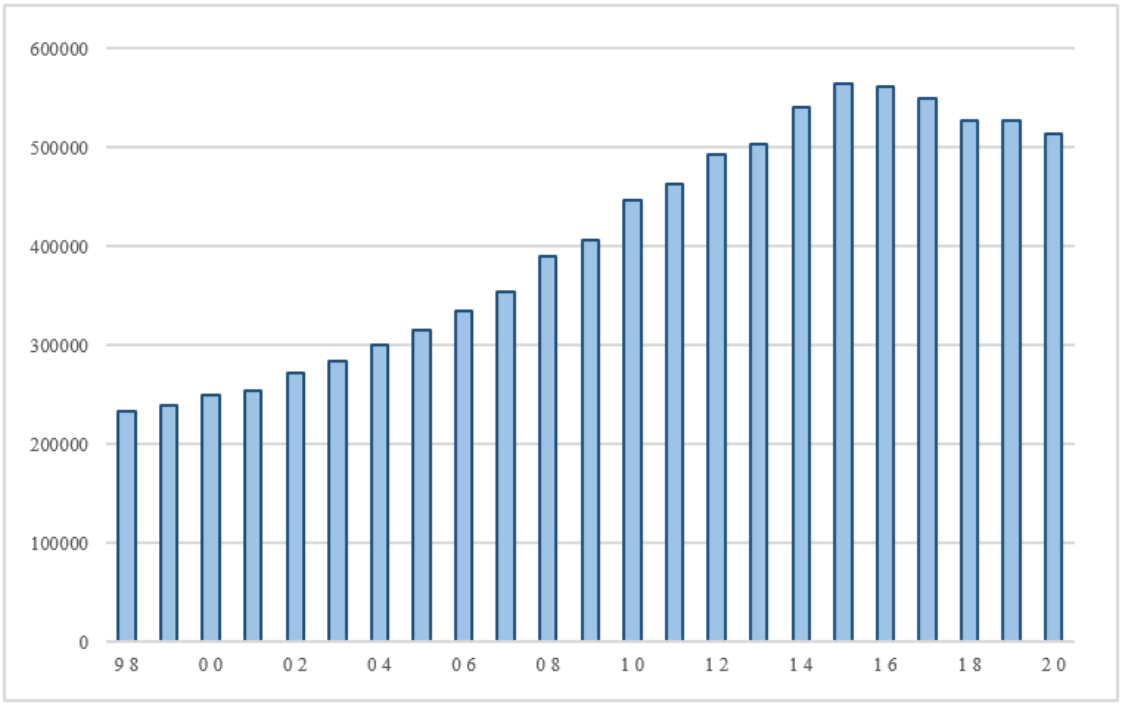

Figure 2. Carbon dioxide emission rates in Saudi Arabia

Source: Compiled by the researchers, based on World Bank data (2020).

2.2.2 Green Economy in the United Arab Emirates

In general, the United Arab Emirates (UAE) is considered one of the leading Arab countries in the environmental field, as it has developed an effective and clear strategy with goals under the slogan "A Green Economy for Sustainable Development." This strategy covers six pathways, including green energy, green cities, green life, green technologies, encouraging investment in the green economy, as well as addressing the impacts of climate change. Therefore, the UAE aims to be a leader in the environmental field, through a sustainable environment and economic growth/prosperity in the long run. It also aims to be a source for recycling green products/services, in addition to exporting them (Official Portal of the Government of the United Arab Emirates, 2023). The following figure (Figure 3) illustrates the most prominent green initiatives in the UAE:

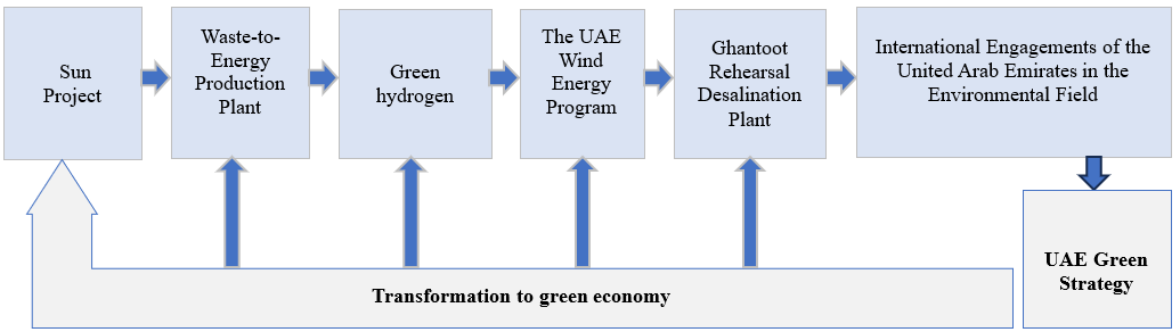

Figure 3. Green Initiatives in the United Arab Emirates

Source: Compiled by the researchers, based on the official website of the Abu Dhabi Future Energy Company "Masdar".

Finally, according to the Environment Agency - Abu Dhabi (2023), by the year 2025, the largest global conference on environmental conservation will be held in Abu Dhabi. The conference aims to establish both the global agenda for biodiversity conservation and climate change, as well as the necessary plans to protect the environment from local and international threats. The following figure (Figure 4) illustrates the upward trend in renewable energy consumption in the United Arab Emirates, which has coincided with an increase in its production as a result of the country's initiatives.

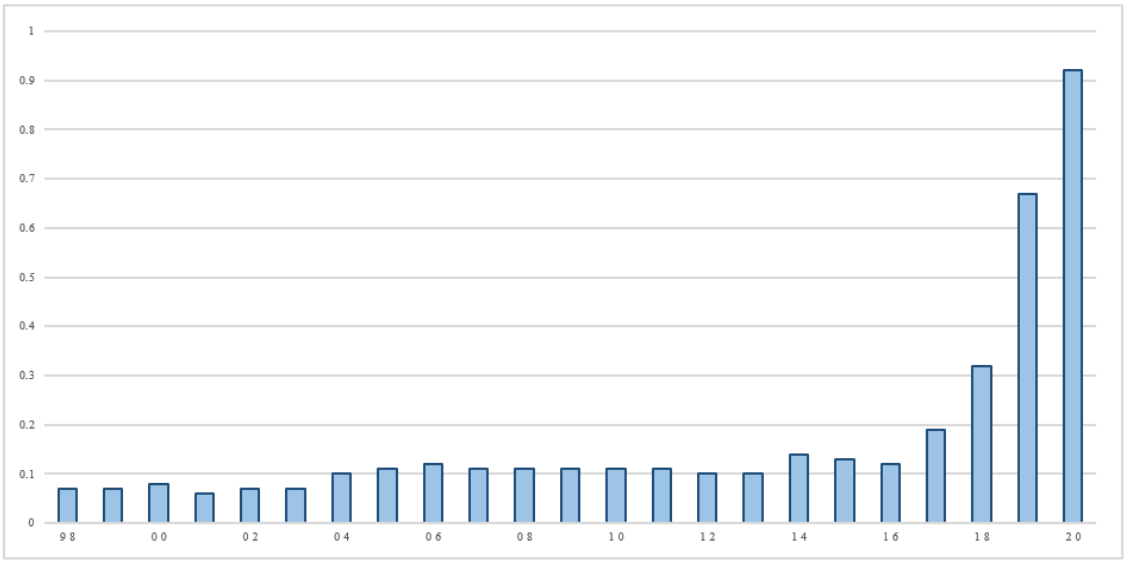

Figure 4. The upward trend of renewable energy consumption in the UAE

Source: Compiled by the researchers, based on World Bank data (2020).

2.2.3 Green Economy in Malaysia

Malaysia is among the first countries to recognize the importance of transitioning to a green economy and has outlined the necessary policies for it. It has worked on enhancing and spreading environmental awareness, encouraging the use of green products, and promoting green businesses/investments. This has led to an increase in the number of green jobs and the advancement towards a sustainable economy (Abdullah et al., 2017), indicating a significant leap in Malaysia's green economy. In just one year (2021) alone, 882 green projects were approved, with a total value of around 3.66 billion Malaysian Ringgit (MIDA, 2022). The following figure (Figure 5) illustrates the most prominent projects contributing to the transition to a green economy in Malaysia:

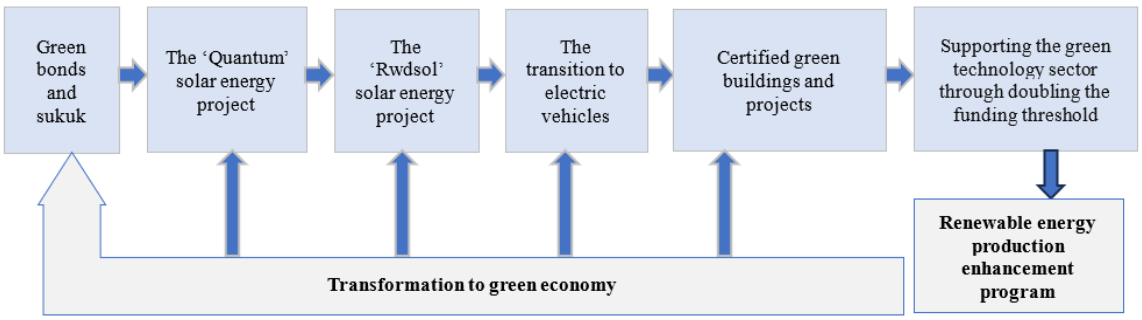

Figure 5. Projects contributing to the transition to a green economy in Malaysia

Source: Compiled by the researchers, based on Clean Malaysia (2016-2017), Yong (2022), and Scatec Malaysia.

Despite the increase in agricultural production in Malaysia due to its geographic location and fertile soil, it has succeeded in transitioning from an economy reliant on agricultural production to a thriving and diversified economy that prioritizes environmental aspects, primarily (Latreche, 2022). This is confirmed by the fluctuation in value-added in the agricultural sector in Malaysia, as illustrated in the following figure (Figure 6).

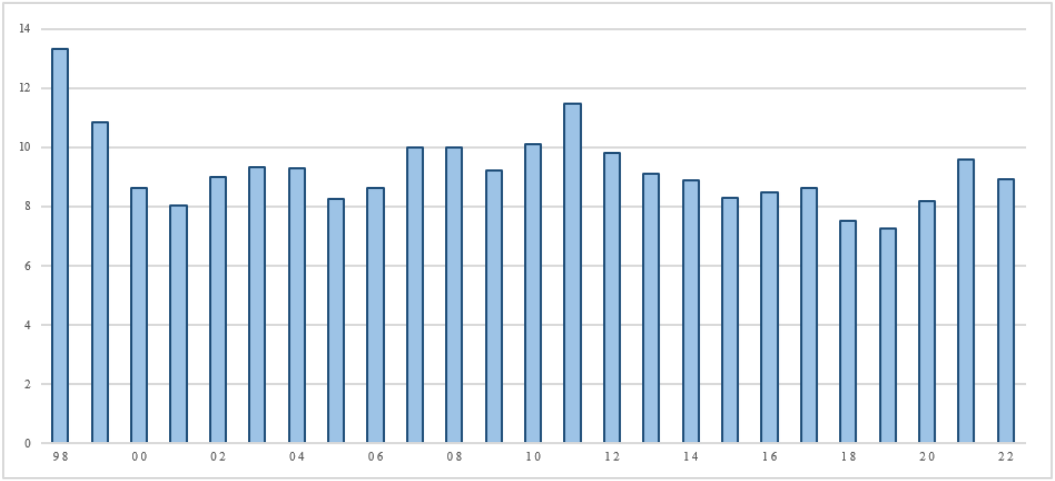

Figure 6. Value-added in the agricultural sector in Malaysia

Source: Compiled by the researchers, based on World Bank data (2020).

2.2.4 Green Economy in Singapore

In addition to the expansion of green spaces in Singapore's territory as a result of efforts by individuals and governments, it is one of the first countries to adopt many sustainability initiatives to preserve the climate, alongside increasing economic growth (Sodastream), as one of the goals of Singapore's Green Plan (2030). The following figure (7) summarizes some of the most important pioneering green projects in this country, as follows:

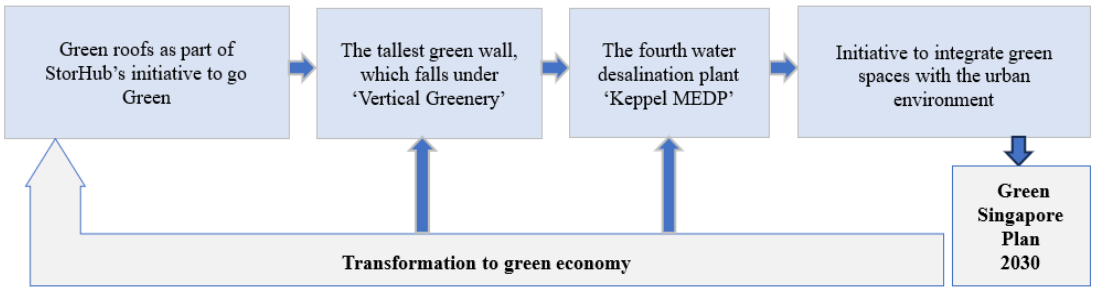

Figure 7. Leading green projects in Singapore

Source: Compiled by the researchers, based on Skyrise Greenery (2021) and the previous reference, Sodastream.

The impact of these pioneering initiatives on carbon emissions is evident, as Singapore is among the countries with the highest reduction rates of carbon dioxide emissions, as illustrated in the following Figure 8.

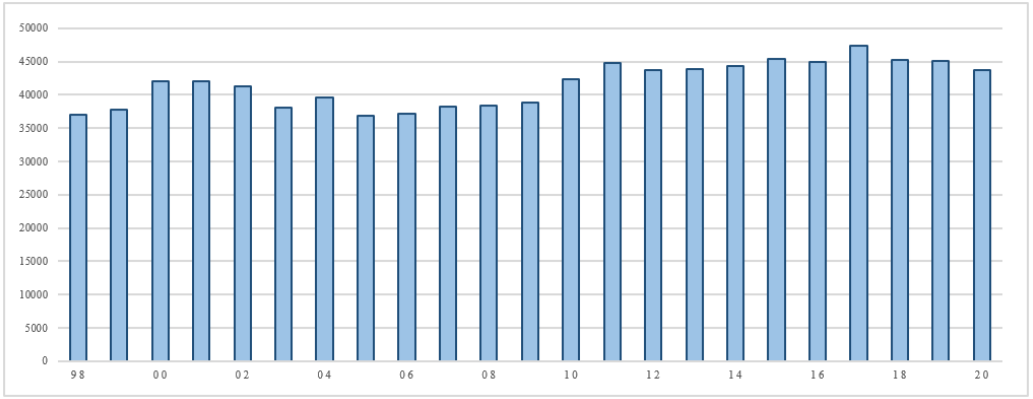

Figure 8. Carbon Dioxide emissions in Singapore

Source: Compiled by the researchers, based on data from the World Bank (2020).

2.2.5 Green Economy in Sweden

In 1967, Sweden enacted environmental protection laws as the first country worldwide. In 1972, it was the first country to host the first United Nations Conference on the Human Environment. Since then and up to the present time, Sweden has been able to achieve high rates of economic growth accompanied by reduced pollution and carbon emissions (Ramadani, 2022). For example, Sweden set a goal to produce 50% of its electricity from renewable energy sources by 2020, but it achieved this goal seven years earlier in 2012. Now, Sweden has set a target to produce 100% of its electricity from renewable energy sources by 2040. In pursuit of this goal, the country has started issuing 'green electricity certificates' to incentivize electricity companies to use renewable energy in production (Sweden Sverige, 2023). The following Figure (9) illustrates some of the most important projects supporting the green economy in Sweden.

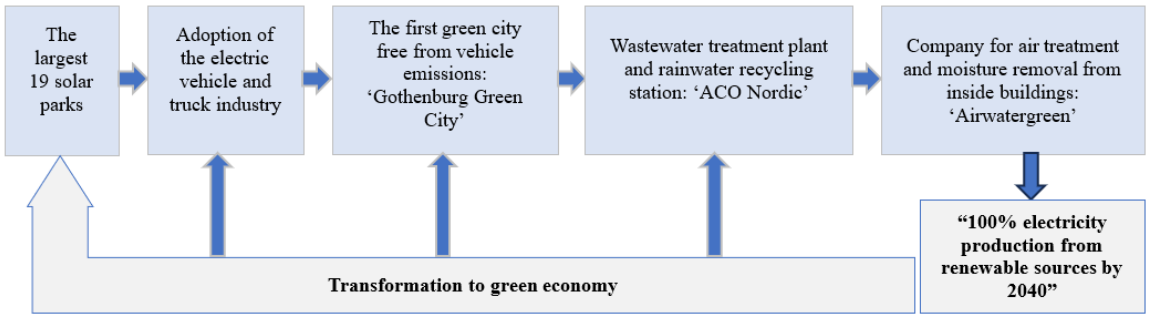

Figure 9. Key renewable energy projects in Sweden

Source: Compiled by the researchers, based on Smart City Sweden (2021) and Swedish Cleantech.

Despite Sweden being one of the highest electricity consumers, this consumption is not accompanied by carbon emissions. This is because the production of this energy relies on environmentally friendly renewable sources, rather than traditional energy sources that are associated with higher rates of harmful emissions. Only 9% of power stations in Sweden rely on fossil fuels (Sweden Sverige, 2023). Figure 10 demonstrates the downward trend of carbon dioxide emissions rates in Sweden.

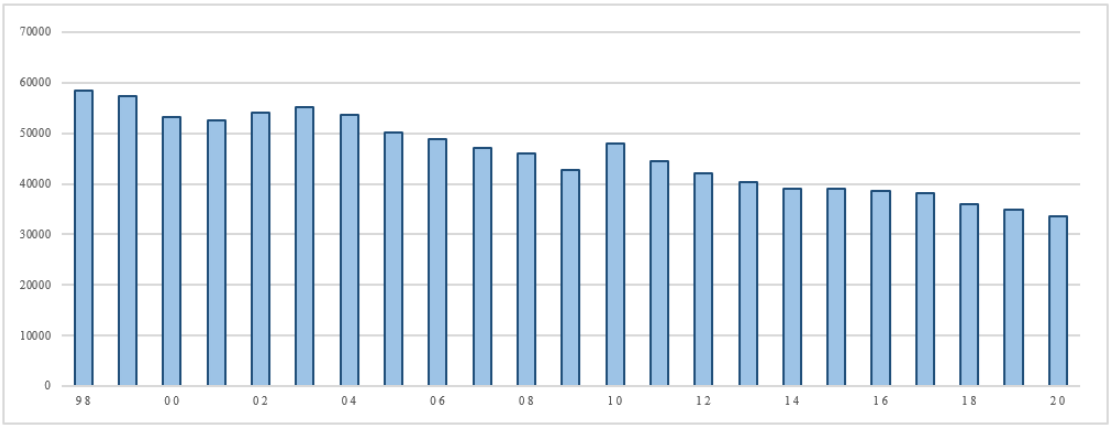

Figure 10. Carbon Dioxide emissions in Sweden

Source: Compiled by the researchers, based on data from the World Bank (2020).

2.3 Scientific Pillars in Sustainability and Economic Growth

A- Theodore Roosevelt Reform Movement (1910) During the early 19th century in America, numerous factors spurred an increase in production, which reached approximately [some value] of global goods. However, this economic growth came at the expense of society and the environment, leading to many negative aspects such as rising congestion, pollution rates, and the spread of several serious diseases. Consequently, Theodore Roosevelt emphasized the necessity of balancing reform and regulation by government intervention to regulate manufacturing operations and mitigate their negative impacts. Indeed, this reform movement played a crucial role in mitigating the severity of these negative impacts in the early 20th century, transforming societies into

modern industrial ones, and improving the quality of life environmentally and socially (Swinth, 2008).

B- Environmental Kuznets Curve (1955) The Environmental Kuznets Curve explains the relationship between economic growth and environmental degradation in the long run in the form of an inverted U-shaped curve, in three stages as follows (Bin Mahad et al., 2020):

Stage One: Economic growth positively influences environmental degradation, as its increase is accompanied by higher rates of pollution and toxic gases such as CO2.

Stage Two**:** Economic growth begins to affect environmental degradation with a semi-inverse relationship, as the increase in economic growth leads to a shift in economic structure from energy-intensive heavy industries to technology-based ones.

Stage Three: The relationship between economic growth and environmental degradation becomes inverse, with technological advancement coinciding with economic growth, replacing environmentally polluting technologies with modern, eco-friendly ones.

C- Venn diagram for Sustainability, indicating the achievement of sustainability through the balancing of Environmental sustainability, Economic sustainability, and Social sustainability, as illustrated in the following Figure (11).

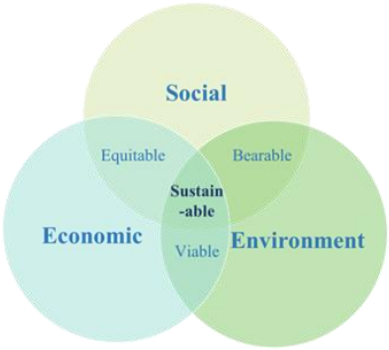

Figure 11. Venn diagram for sustainability

Source: Prepared by the researchers, based on Circular Ecology.

The essential results that enhance sustainability processes become evident through the common areas among the three types. Equality is achieved through social and economic sustainability, while probability is achieved through social and environmental sustainability. Applicability is achieved through economic and environmental sustainability. Finally, actual sustainability and circular economy are achieved through all three types of sustainability mentioned above.

3. Study Methodology

This study has relied on the descriptive analytical approach, involving a review of existing literature on the study topic, as well as clarifying related concepts and theories. Additionally, the study has employed the econometric analysis approach, using Panel Data models, which provide more accurate and efficient interpretive results (Eric, 2019).

3.1 Panel Data Models Description

Panel Data models, especially favored by quantitative economic studies, are of great interest due to their distinctive features compared to other models. These models take into account both the time factor and the differences between cross-sectional units, integrating the characteristics of time series data with cross-sectional data (Amer, 2015). This integration increases the amount of data, hence enhancing the efficiency and degrees of freedom in statistical analysis. Moreover, they address the issue of heterogeneity and outcome bias, which may appear in other model datasets. Additionally, Panel Data models excel in analyzing dynamic adaptation, making them more suitable for studies related to economic cycles, such as unemployment and poverty rates studies, among others (Batal, 2022). The specifications of Panel Data models can be determined based on fundamental assumptions (Colonescu, 2016; Khalaf et al., 2020; Batal, 2022), as follows

First, The pooled Regression Model (PR), also known as the Fixed Effects Model, assumes that all (β1) coefficients are constant over the entire period. The PR model can be formulated as follows:

$$y_{it} = \text{Œ} =_1 + \text{Œ} =_2 x_{it} + e_{it}$$

To estimate the parameters of this model, the Ordinary Least Squares (OLS) method is used, making it one of the simplest Panel Data models.

Secondly, the Fixed Effects Model (FE) agrees with the PR model in assuming constant coefficients over the period but differs in that it analyzes the behavior of each unit separately. Therefore, to estimate the parameters of this model, the method of Least Squares Dummy Variables is used, by including fixed dummy variable coefficients. The FE model can be formulated as follows:

$$y_{it} = \text{Œ} =_{1i} + \text{Œ} =_2 x_{it} + e_{it}$$

Thirdly, the Random Effects Model (RE) agrees with the FE model in analyzing the behavior of each unit separately - meaning it has the same cross-section. However, it assumes the variation of this constant-coefficient to be random. The RE model can be formulated as follows:

$$y_{it} = \text{Œ} =_{1i} + \text{Œ} =_2 x_{it} + \text{Œ}O_{it}, where: \text{Œ}O_{it} = u_i + e_{it}$$

Since this model includes two components of error (ε and ν), estimating its parameters will require the use of Generalized Least Squares (GLS) method, as it is difficult to estimate them using Ordinary Least Squares (OLS) method

3.2 Research Hypotheses

To analyze the impact of the green economy on economic growth in the countries under study during the period (1998-2022), the researchers aim to test the validity of the following hypotheses:

The existence of a significant positive relationship between value added in the agricultural sector and Gross Domestic Product (GDP).

The existence of a significant positive relationship between renewable energy consumption and Gross Domestic Product (GDP).

The existence of a significant negative relationship between carbon dioxide emissions and Gross Domestic Product (GDP).

The existence of a significant positive relationship between per capita freshwater resources and Gross Domestic Product (GDP).

3.3 Econometric Model and Data Used

This section focuses on the practical aspect, where longitudinal Panel Data models have been described, as they are more accurate, as mentioned earlier, and suitable for the study's data, to clarify the extent of the Gross Domestic Product's (GDP) impact -as a dependent variable- by the independent variables -as follows-, which were selected based on previous studies and literature. To obtain the study's data for all variables, official data from The World Bank (2023) has been relied upon. Finally, descriptive tests were conducted to determine the general direction of the

variables under study, using the statistical program E-views, to estimate

the relationship between the dependent variable and the independent variable

3.4 Description of the Study Model

$$GDP = v\ddot{u}_0 + v\ddot{u}_1 VAA - v\ddot{u}_2 CRE - v\ddot{u}_3 CDE + v\ddot{u}_4 PCW + \text{Œ}\mu_t$$

After identifying the study variables and hypotheses to be tested, the Panel Data models have been described to analyze the impact of independent variables on Gross Domestic Product (GDP). The following functional relationship illustrates the overall picture of the study model:

The dependent variable is represented by Gross Domestic Product (GDP), while the independent variables include: Value Added in Agriculture (VAA), Consumption of Renewable Energy (CRE), Carbon Dioxide Emissions (CDE), and Per Capita Freshwater Resources (PCW). The term ε denotes the error term of the equation. As mentioned earlier, this study assumes the following:

- There is a positive relationship between GDP and Value Added in Agriculture.
- There is a positive relationship between GDP and Consumption of Renewable Energy.
- There is a negative relationship between GDP and Carbon Dioxide Emissions.
- There is a positive relationship between GDP and Per Capita Freshwater Resources.

The model variables will be described as follows:

Firstly, the Dependent Variable: Gross Domestic Product (GDP) is one of the most important economic indicators of a country's performance, representing all that is produced within the country. The following Figure (12) illustrates the Gross Domestic Product of the countries under study - in current US dollars -, which increases over time. The figure also illustrates the extent of GDP in the Kingdom when compared to the other countries under study.

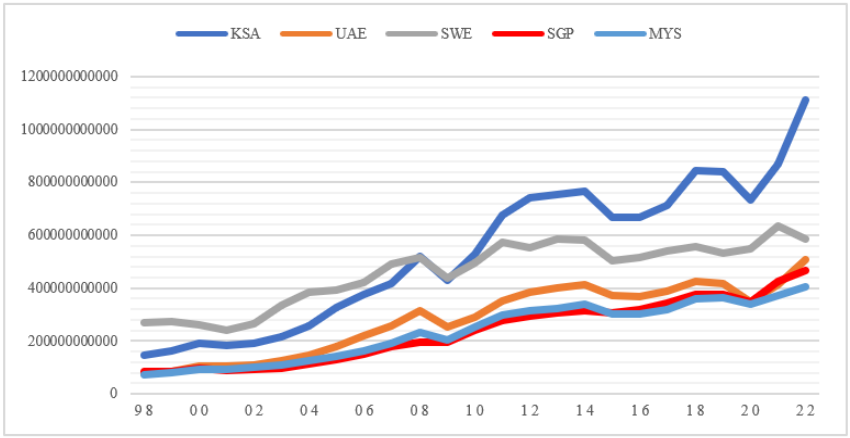

Figure 12. Gross Domestic Product during the period (1998-2022) to all study countries

Source: Compiled by the researchers, based on data from the World Bank (2023).

Secondly, the Independent Variables, which include the following:

1- Value Added in the Agricultural Sector (VAA): It represents the net output after subtracting inputs from outputs. The following Figure (13) illustrates VAA as a percentage of the total GDP. Despite the downward trend of this variable with some fluctuations during the study period, it is observed from the figure an increase in VAA in Malaysia when compared to the other countries under study. The reason for this may be attributed to the nature of the climate and the availability of fertile land suitable for agriculture, making it a country whose economy relies primarily on agriculture (Latreche, 2022).

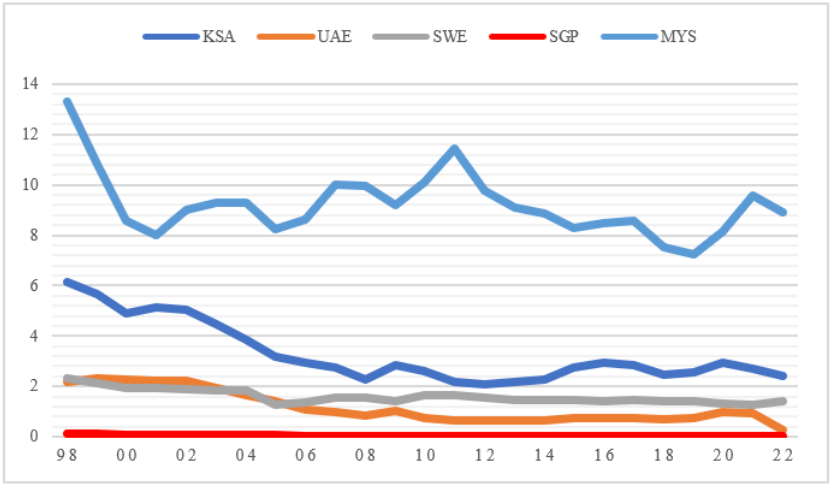

Figure 13. Value added in the agricultural sector during the period (1998-2022) to all study countries

Source: Compiled by the researchers, based on data from the World Bank (2023).

2- Renewable Energy Consumption (CRE) represents, in this study, the proportion of total final energy consumption. Generally, as depicted in Figure 14, there is an observed increase in this variable in Sweden, while its values decrease in the rest of the study countries, approaching the horizontal axis. This can be attributed to the rapid growth of solar energy projects in Sweden, as the growth rate of renewable energy projects there increased to 33% in 2022 (Santos, 2022).

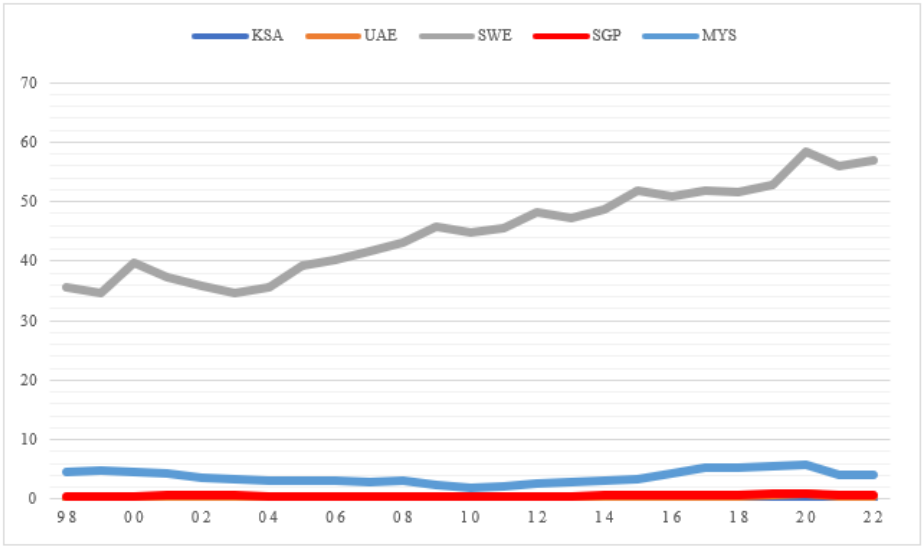

Figure 14. Renewable energy consumption during the period (1998-2022) to all study countries

Source: Compiled by the researchers, based on data from the World Bank (2023).

3- Carbon Dioxide Emission (CDE) represents, in this study, the emissions of carbon dioxide in kilotons, which often result from the burning of fossil fuels. Figure 15 illustrates the extent of the increase in this variable in the Kingdom compared to the other countries under study. The reason for this could be attributed to 90% of these emissions stemming from fuel combustion, alongside increasing rates of oil production, as well as a rise in the population growth rate (Qasim et al., 2023).

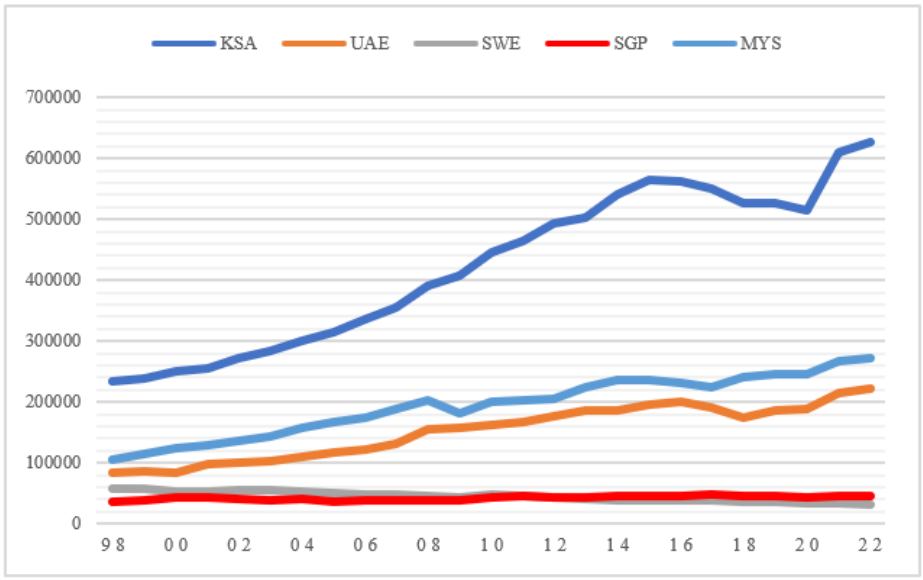

Figure 15. Carbon Dioxide Emissions during the period (1998-2022) to all study countries

Source: Compiled by the researchers, based on data from the World Bank (2023).

4- Per Capita Renewable Internal Freshwater Resources (PCW) refers to the share of freshwater resources such as rivers and groundwater resulting from rainfall, measured in cubic meters. Generally, as depicted in Figure 16, there is an observed increase in this variable in Malaysia from the beginning of the study period until 2021; however, after that year, it became the highest in Sweden. The figure also illustrates the extent of the decrease in PCW in the rest of the countries under study. This could be attributed to various reasons, the most significant being the spread of desert climate conditions in those countries.

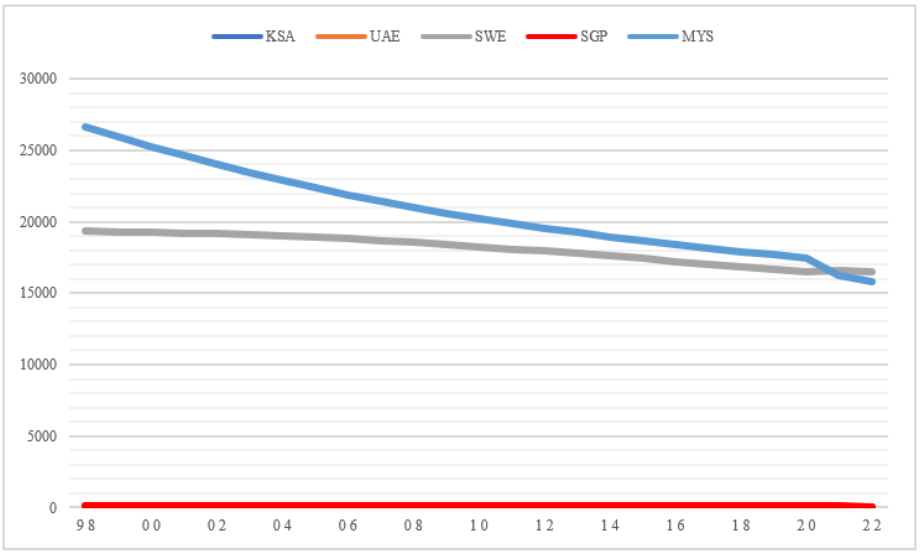

Figure 16. Per capita renewable internal freshwater resources during the period (1998-2022) to all study countries

Source: Compiled by the researchers, based on data from the World Bank (2023).

4. Results and Discussion

4.1 Descriptive Statistics of the Study Variables and Linear Correlation Among the Independent Variables

To provide a general overview of the study sample, descriptive statistical characteristics of the study variables have been identified over the period (1998-2022) (Table 1).

Table 1. Descriptive statistics of study variables

	GDP	VAA	CRE	CDE	PCW
Mean	3.50E+11	3.065588	9.928435	171071.0	7809.956
Median	3.23E+11	1.827755	0.580000	129458.7	118.1863
Maximum	1.11E+12	13.31224	58.40000	626689.9	26592.64
Minimum	7.22E+10	0.028110	0.010000	31585.75	4.914105
Std. Dev.	2.04E+11	3.366203	18.02632	153558.2	9647.554
Skewness	0.896930	1.210913	1.599884	1.317763	0.503906
Kurtosis	3.823199	3.154359	3.792384	3.960723	1.403075
Jarque-Bera	20.28955	30.67221	56.59578	40.98430	18.57217
Probability	0.000039	0.000000	0.000000	0.000000	0.000093
observations	125	125	125	125	125

Due to the issue of multicollinearity among the independent variables, which is one of the main challenges facing the data, an analysis of this correlation has been conducted (Table 2). The table indicates that all correlation coefficients between the independent variables are less than 0.70. Therefore, it can be said that the condition of independence of the independent variables has been met (Gujarati & Porter, 2009).

Table 2. Correlation matrix of independent variables

Correlation	GDP	VAA	CRE	CDE	PCW
GDP	1				
VAA	-0.223846	1			
CRE	0.289532	-0.157394	1		
CDE	0.569253	0.250778	-0.417964	1	
PCW	-0.079512	0.635966	0.577789	-0.263579	1

4.2 Regression Model Estimation

The estimation relied on the three previously mentioned Panel Data models: PR, FE, and RE (Table 3). By estimating the regression equation mentioned earlier in the linear form, Table 3 shows the significance of all variables in models PR and RE. However, according to the FE model, only renewable energy consumption (CRE) and carbon dioxide emissions (CDE) showed significance. This implies that neither the value added in the agricultural sector (VAA) nor the per capita share of renewable internal freshwater resources (PCW) affects the gross domestic product (GDP). Additionally, the overall significance of all models (F-Test) was evident. Finally, the coefficient of determination illustrates the extent to which independent variables can explain the variations in the dependent variable (GDP). It reached its maximum in the FE model, where the independent variables explain 87% of the variations in GDP.

Table 3. Regression model estimation results

Dependent Variable: GDP				
Total Panel (balanced) observations: 125				
	Variables	PR	FE	RE
coefficient	C	1.40E+11***	-1.34E+11*	1.40E+11***
T-Stat		8.232034	-1.774935	10.76605
St. Error		1.70E+10	7.57E+10	1.30E+10
coefficient	VAA	-3.84E+10***	-8.77E+09	-3.84E+10***
T-Stat		-5.472160	-0.851132	-7.156623
St. Error		7.03E+09	1.03E+10	5.37E+09
coefficient	CRE	4.49E+09***	1.57E+10***	4.49E+09***
T-Stat		4.121912	7.429344	5.390737
St. Error		1.09E+09	2.12E+09	8.33E+08
coefficient	CDE	1311602.***	2084358.***	1311602.***
T-Stat		18.12426	15.33258	23.70334
St. Error		72367.23	135943.0	55334.07
coefficient	PCW	7504019.***	-230410.9	7504019.***
T-Stat		2.584255	-0.044364	3.379751
St. Error		-4.642306	5193604.	2220287.
R-squared		0.791510	0.882168	0.791510
Adjusted R-squared		0.784560	0.874042	0.784560
F-Statistic		113.8918***	108.5565***	113.8918***
		* 10%, ** 5%, *** 1%		

To ensure the absence of problems that negatively affect the accuracy of the results, the Jarque-Bera test was conducted for all models. The results confirmed that the residual error follows a normal distribution (Table 4).

Table 4. The results of the pooled Regression Model (PR) estimation

Dependent Variable: GDP				
Included observations: 125				
Variable	Coefficient	Std.Error	t- Statistic	Prob.
C	1.40E+11	1.70E+10	8.232034	0.0000
VAA	-3.84E+10	7.03E+09	-5.472160	0.0000
CRE	4.49E+09	1.09E+09	4.121912	0.0001
CDE	1311602.	72367.23	18.12426	0.0000
PCW	7504019.	2903745.	2.584255	0.0110
R^2	0.791510	Mean dependent var		3.50E+11
$\overline{R^2}$	0.784560	S.D dependent var		2.04E+11
S.E of reg.	9.46E+10	Akaike info criterion		53.42286
Sum squared reside	1.07E+24	Schwarz criterion		53.53599
Log-likelihood	-3333.929	Hannan- Quinn criteria.		53.46882
F-statistic	113.8918	Durbin-Watson stat		0.258446
Prob (F-statistic)		0.000000		

Additionally, Lagrange Multiplier Tests for Random Effects (Table 5) and the Correlated Random Effects-Hausman Test (Table 6) were conducted to differentiate between PR and RE, and between FE and RE, respectively. Table 5 indicates that the Random Effects (RE) model is the most suitable for estimating the relationship, as the Probability is less than 5%, implying rejection of the null hypothesis and acceptance of the alternative hypothesis. To differentiate between the Random Effects (RE) model and the Fixed Effects (FE) model, the Hausman Test was used and the results are presented in Table 6. As evident from Table 6, the Fixed Effects model is the most suitable for estimating the relationship between the studied variables, as the Probability is less than **5%,** indicating rejection of the null hypothesis and acceptance of the alternative hypothesis. Therefore, the study's questions will be answered using the Fixed Effects model.

Table 5. LM Breush-Pagan

	Test Hypothesis		
	Cross-section	Time	Both
Breusch-Pagan	101.3363	97.77763	101.3363
Prob.	(0.0000)	(0.0000)	(0.0000)

Table 6. Hausman Tests

Test Summary	Chi-Sq. Statistic	Chi-Sq. d.f.	Prob.
Cross-section random	89.248488	4	0.0000

3.4 Discussion of Results

The analysis of the results provides insights into the impact of green economy indicators on economic growth across the studied countries (Table 7). The study found that while some results aligned with prior expectations, others deviated, highlighting the complexity of these relationships.

For the value-added in the agricultural sector (VAA), the study results showed a statistically insignificant impact on Gross Domestic Product (GDP), which contrasts with previous findings such as Golline (2010), who indicated that an increase in agricultural value-added should positively influence GDP. The present study's results align more with Alhshem and Ghader (2022), who suggested that the relationship between agriculture's value-added and economic growth may not be straightforward or universally applicable. The absence of a significant effect in the current study could be due to the limited role of agriculture in highly industrialized or resource-dependent economies, where other sectors, such as oil or services, dominate economic output.

The relationship between renewable energy consumption (CRE) and GDP was statistically significant and positive, consistent with the findings of the International Renewable Energy Agency (IRENA, 2016), which noted that increasing the share of renewable energy consumption could boost global economic growth. This positive association supports the idea that investment in renewable energy not only benefits the environment but also stimulates economic activity by creating new industries and employment opportunities. The current study's findings strengthen the argument for promoting renewable energy consumption as a pathway to sustainable economic growth.

However, the analysis of carbon dioxide emissions (CDE) presented unexpected results, as the relationship between CDE and GDP was found to be statistically insignificant. This contradicts the Environmental Kuznets Curve (EKC) hypothesis, which suggests that at certain stages of economic development, an inverse relationship should be observed between economic growth and environmental degradation (Bin Mahad et al., 2020). The results may reflect the economic structure of the countries studied, where industries contributing to higher GDP, such as manufacturing and energy production, still rely heavily on fossil fuels. The observed lack of a significant relationship could indicate that economic growth continues to occur without substantial environmental considerations, underscoring the need for policies that target green growth rather than mere economic expansion.

Lastly, the study found no significant impact of per capita freshwater resources (PCW) on GDP, which was contrary to the initial assumption that an increase in water availability would positively affect economic growth. This result could be influenced by the geographic and climatic diversity of the countries included, some of which, like Saudi Arabia and the UAE, face arid conditions where freshwater availability does not directly translate into higher economic productivity. Additionally, as suggested by the Ministry of Environment, Water, and Agriculture (2018), the costs associated with water treatment and desalination in water-scarce regions might outweigh the potential economic benefits, thereby diminishing the positive impact of freshwater resources on GDP.

Overall, while the study confirmed some expected relationships, such as the positive impact of renewable energy consumption, it also revealed the complexities in the interactions between economic growth and environmental factors, suggesting the need for more tailored green economy policies depending on each country's unique economic and environmental context.

Table 7. Results analysis

Independent variables	"Significance and conformity."	Analysis
VAA	Statistically insignificant Contrary to expectations -8.77E+09"	It is expected that an increase in value added in the agricultural sector would lead to an increase in gross domestic product, as stated in many studies, such as the study by Golline (2010). However, this study has found no effect of this variable on gross domestic product. This could be attributed to the lack of conclusive evidence confirming the causal relationship between these two variables (Alhshem & Ghader, 2022).
CRE	"Statistically significant Matches expectations 1.57E+10"	As expected, the study found a positive relationship between renewable energy consumption and gross domestic product, a finding corroborated by the International Renewable Energy Agency (IRENA, 2016). IRENA states that doubling the size of renewable energy sources - and consequently their consumption - will lead to an increase in global gross domestic product by up to 1.1% in 2030, equivalent to about 1.3 trillion dollars added to the total global gross domestic product.
CDE	"Statistically insignificant Contrary to expectations 2084358."	It is expected that there will be an inverse relationship between carbon dioxide emissions and gross domestic product. However, the current study has proven otherwise. This could be attributed to the main reason behind the increase in carbon dioxide emissions, which is the burning of fossil fuels - such as oil, gas, and coal - resulting from certain industries. These industries, in turn, contribute to an increase in gross domestic product, regardless of their environmental impact. Therefore, many countries are striving towards a green gross domestic product, which takes into account this environmental impact. This inverse relationship aligns with what Kuznets Simon referred to in his Environmental Kuznets Curve hypothesis. In the absence of environmental awareness, an increase in output leads to more natural resource usage as inputs, resulting in more pollution and emissions (Bin Mahad and others, 2020).
PCW	"Statistically insignificant Contrary to expectations -230410.9"	Based on the assumptions of the study, it was expected that an increase in the per capita share of freshwater resources would lead to a positive impact on gross domestic product. However, the results of this study have contradicted these expectations. This could be attributed to several reasons, such as the presence of desert climates in some countries, which means that the freshwater resources available there are insufficient in quantity to significantly impact gross domestic product rates. Furthermore, the reason for this inverse relationship could be that an increase in the per capita share of freshwater resources necessitates the state to incur additional costs to desalinate and make the water suitable for drinking, leading to a decrease in gross domestic product. This inverse relationship aligns with the statement made by the Ministry of Environment, Water, and Agriculture (2018), which suggests that growth in gross domestic product through increased industrial activities requires large quantities of water resources, thereby inversely affecting the per capita share of those resources.

5. Conclusion

The researchers aimed, through this study, to address the question that encapsulates the research problem, which revolves around the impact of green economy indicators on economic growth rates in some Arab - Saudi Arabia, United Arab Emirates - and non-Arab countries - Malaysia, Singapore, and Sweden - during the period from 1998 to 2022. In terms of theoretical grounding related to the study topic, the most relevant literature/studies were reviewed, from which variables were identified, and the standard model for the study was formulated. Subsequently, the reality of the green economy in the five Arab and non-Arab countries under study was discussed.

The researchers adopted the econometrics analysis method to test the hypotheses of the study, represented by the Panel Data model with its three forms (PRM, FEM, and REM). This was done by using three models to measure the impact of green economic indicators, namely: Value Added in the Agriculture Sector (VAA), Consumption of Renewable Energy (CRE), Carbon Dioxide Emissions (CDE), and per capita share of renewable freshwater resources (PCW), on Gross Domestic Product (GDP). To determine the extent of the impact of green economy indicators in the countries under study, four hypotheses were tested, focusing on the positive impact of both values added in the agriculture sector, consumption of renewable energy, and per capita share of freshwater

resources. In addition to the negative impact of carbon dioxide emissions on the GDP rate.

As expected, the results showed, confirming what was asserted by the International Renewable Energy Agency (IRENA, 2016), the presence of a significant positive relationship between renewable energy consumption and Gross Domestic Product (GDP). Contrary to expectations, however, the results indicated a significant negative relationship between carbon dioxide emissions and GDP, in line with the hypothesis of the Environmental Kuznets Curve (Bin Mahad and others, 2020). Finally, the study concluded that the Gross Domestic Product is not affected by either the value added in the agriculture sector or the per capita share of freshwater resources.

6. Recommendations

Overall, it was observed that despite the efforts of governments in some of the countries under study to protect their environmental resources and create a balance between the needs of current and future generations, they still fall short of the required level. Therefore, the researchers recommend several key actions to support both economic growth and environmental sustainability. First, there is a need to enhance policies and measures that promote renewable energy consumption, as doing so will further stimulate economic growth while reducing reliance on non-renewable energy sources. Second, stricter regulations should be implemented to reduce carbon dioxide emissions, helping to mitigate their negative impacts on economic development and contributing to a healthier environment. Finally, increased investments in sustainable agricultural practices and water resource management are essential for ensuring long-term environmental sustainability and securing future economic prosperity. These recommendations aim to balance the goals of environmental protection with continued economic advancement.

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