International Journal of Economics and Financial Issues

ISSN: 2146-4138

available at http: www.econjournals.com

International Journal of Economics and Financial Issues, 2023, 13(3), 33-45.

Green Financing as a Tool to Mitigate Climate Change for Sustainable Development: An Insight form Egypt

Marwa Elsherif*

Helwan University, Cairo, Egypt. *Email: marwassem@yahoo.com

Received: 24 January 2023 **Accepted:** 05 April 2023 **DOI:** https://doi.org/10.32479/ijefi.14235

ABSTRACT

Climate change is undoubtedly one of the long-term challenges confronting humanity across the globe. Most of the economies have taken serious initiatives that support reduce greenhouse gas emissions as well as accelerate financial flows to clean and sustainable projects. This study investigates the influence of green financing on environmental sustainability – represented by climate change mitigation- in Egypt from 1990 to 2021. Augmented Dickey–Fuller, Phillip-Peron unit root tests and quantile autoregressive distribute lag model were employed for empirical estimates. Results reveal that green financing is negatively associated with greenhouse gas emissions. It is also worth noting that research and development investment promotes environmental sustainability, while population growth hinders it. Moreover, economic growth does not play a vital role in climate change. There are still many fences to green finance that need to be addressed. It is recommended that policymakers push the financial sector to adopt a green finance strategy to further the goals of long-term sustainable development.

Keywords: Green Finance, Climate Change, Sustainable Development
JEL Classifications: C3, O13, Q1, Q5

1. INTRODUCTION

Across the globe, climate change and sustainability have received a lot of attention. It is stated in the 2015 Paris Agreement, which was adopted as part of the United Nations Framework Convention on Climate Change (UNFCCC), that world leaders have come to a general consensus on this subject[1]. As a result of the agreement, the member countries are obliged to work together to mitigate climate change. "Greenhouse gas (GHG)[2] emissions are externalities and represent the biggest market failure the world has seen" (Stern, 2008, p. 1)[3]. Global warming must be kept below 2°C by 2035, which will require $53 trillion for investments in energy-related projects (OECD, 2018a).

Additionally, losses resulting from damage caused by natural disasters and climate change have magnified since the eighties, consequent negative repercussions are expected to slow global economic growth and adversely affect the performance of financial markets (World Bank, 2020). The transition to a green economy is crucial for the world to avoid tragic climate change. The International Energy Agency (IEA) estimated that an additional investment of $26 trillion in renewable energy and energy efficiency is required between 2015 and 2040 (IEA, 2021). Overall, reaching the global targets in 2030 may require mobilizing green finance of $90 trillion (GCEC, 2018).

1. The 2015 Conference of Parties (COP)21 held in Paris, following the 1992 UNFCCC and the 1997 Kyoto Protocol.
2. The UN identifies seven main greenhouse gases (GHG) that are major drivers of climate change: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulphur hexafluoride (SF_6) and nitrogen trifluoride (NF_3). As CO_2 is by far the most common GHG caused by human activity, it is sometimes used as a shorthand expression for all greenhouse gases.
3. A comprehensive and illuminating departure point for understanding the economics of climate change is the 2007 Stern Review.

One of the most difficult challenges is financing climate change mitigation and adaptation actions and their long-term viability. The Intergovernmental Panel on Climate Change (IPCC) report noted the importance of mobilizing green finance in order to limit global warming to 1.5°C and prevent catastrophic climate change. Fully implementing the Paris Agreement to meet this climate target will require $1.5 trillion in green financing annually through 2030 (IPCC, 2022). At the same time, surging green finance is key to streaming energy demand, which is fueled by economic growth, population growth and enhanced energy access (Larsen, 2019). As a result, scaling up green finance is mandatory. A major shift in investment patterns is needed to provoke green finance, and that requires a distinct focus of regional government policies. Recently, there is a growing number of countries supporting green finance and new measures are being implemented. Learning from these experiences could assist to arrange effective policies to further foster green finance (UNEP, 2017).

As green financing aimed at mitigating climate change by decreasing the carbon drifts, there is a need to identify the nexus between green financing, carbon drifts and climate change mitigation. In addition, to present the policy guidelines for key stakeholders if suggested policy measures applied effectively to enhance climate control specifically during crises periods (Moz-Christofoletti and Pereda, 2021; Pawar and Wu, 2021).

Although there are many empirical studies across different regions and countries regarding this topic, few studies are available in the context of Egypt. At this end, this study is an attempt to investigate the impact of green financing on climate change in Egypt between 1990 and 2021 along with other control variables that are influencing it. Hereby, the study signifies the following major parts; after the introduction section 2 reviews the literature on aligning green finance and climate change. Subsequently, section 3 is an empirical insight with special focus on Egypt. Section 4 discusses data and the econometric model followed by results and discussion in section 5. Last section concludes.

2. LITERATURE REVIEW ON GREEN FINANCE AND CLIMATE CHANGE

At the beginning of the eighteenth century, specifically with industrial revolution which was a transition to new manufacturing processes that involves burning fossil fuels like oil, gas and coal. Since 1970, CO_2 emissions have increased by about 90%. Green Finance is becoming a strategic and viable tool to drive a world with lower carbon, healthy climate and less environment damage (Muchiri et al., 2020)[4]. As mentioned by Ehlers and Packer (2016) green finance enhances the natural environment along with managing current and future environmental risks. It includes products (services) that will draw capital towards green industry sectors[5]. Green finance mainly promotes the flow of financial instruments towards the development of sustainable business projects, social investment, social trade and environmental policies (Sarker et al., 2022). It provides a vital way to introduce and develop policies to reduce global warming (BIS, 2017).

There are several concepts related to green finance, sustainable finance, climate finance and low carbon finance. All these concepts refer to the use given to financial resources. The concept of green finance came into the discussion when the world started to face climate changes which are not in their favor. The importance of green finance has been highlighted by initiating investment products that protect the environment and provide economic prosperity (Akomea-Frimpong et al., 2021)[6].

Green finance addresses environmental and climate change issues. According to Sachs et al. "We need to expand financing for investments that benefit the environment. New financial instruments and policies are needed, including green bonds, green banks, carbon market instruments, fiscal policy, green central banking, fintech, and community based green funds, collectively known as green finance" (2019, p. 5). In other words, public financing instruments and policies are also considered to be included in green finance.

Arkhipova (2017) argued that green financing refers to investments in sustainable environmental projects, and solid policies that aim to encourage the development of the sustainable green economy. These financial projects as mentioned by Dikau and Volz (2021) can be related to industrial pollution control, GHG emissions, or biodiversity protection. Weber and Elalfy (2019) highlighted that green financing in general a broader term which most studies available in the literature describe it as financing of sustainable environmentally friendly projects, therefore, green loan play role of a bridge which connects financial institutions and environment-friendly industries.

Notwithstanding its popularity in recent years, green finance remains a complex topic. It refers to financial investments made specially to promote environmental protection. Green finance includes green asset financing, green loans and green investing (Sun et al., 2020)[7]. Green finance laws govern loan availability in less developed financial ecosystems and state-owned enterprises. As claimed by Yu and Solvang (2020), it should utilize existing bank and corporate relationships as well as current technology. Carbon emission-based green finance schemes often benefit both companies and suppliers, it helps the industrial sector as well (Bodnar et al., 2018). In conclusion, the positive relationship between green finance instruments and business innovation makes green finance a promising tool for transition to intelligent and sustainable manufacturing (Liu and Wu 2019). Global capital market monitoring of green bonds

4. Whether it's sustainable finance or environmental finance or say green investment or climate finance; all the terms are relatively used in green finance.
5. The most common green industry sectors include industry that focuses on renewable energy production, storage, distribution, transport (green), recycle, prevent pollution, and conserve water as well as forest. It encourages approach, strategy, culture, business process focusing environment throughout the industry.
6. Banks created and allocated green financial products but now, green finance policies are binding on financial institutions and corporates.
7. The private sector may help finance environmental projects that the government doesn't fund sufficiently. Environmental degradation is more probable in poorer countries, necessitating significant green financing initiatives. Developing country governments may create and implement policies that promote green finance.

is helping factor to develop a more dynamic green finance ecosystem (Gerlagh et al., 2018).

In line with recent studies by Tiep et al. (2021), Yang et al. (2021), Li et al. (2022), He et al. (2020) and Mohsin et al. (2021), Ali et al. (2022) environment has been changing rapidly since the mid-1990s, various procedures and tactics are proposed and put into practice at various scales in order to lessen the impact of climate change. According to Liu et al. (2021), Ikram et al. (2019) and Shah et al. (2019), the carbon strategy and execution is one of the biggest new businesses to deal with climate change.

Sen and Schickfus (2020) highlighted that climate change is global, its origins are local, and its effects will be felt only after our generation's lives. The effects are most likely irreversible, but the science must address significant layers of uncertainty[8]. Currently, ecologists recommend stabilizing the stock of GHG emissions below a certain target and thus acting to control and reduce new flows or emissions in order to avoid causing irreversible damage beyond 2050 according to Coscieme et al. (2021). On the other hand, central banks may be mandated to actively use the tools at their disposal to promote green investment or discourage brown investment and play a developmental role (Dafe and Volz 2015).

In the same context, the mitigating measures naturally have a cost of abatement. Changes have to occur in production and consumption habits, and not just the obvious candidates like transportation and energy (UNEP, 2017). There are many options for abatement, ranging from improving current energy efficiency, to changing the energy matrix, to renewable sources, to tackling non-energy emissions/damages in agriculture and deforestation[9] (Saint et al, 2021). Ironically, in some options, benefits exceed costs and might create a new, virtuous, low carbon growth cycle (Matthews et al., 2017).

Recent literature on the optimal financial response to climate change has focused on the trade-off between direct costs and the potentially uncertain long-term benefits of investments to reduce carbon emissions (Giglio et al., 2021). In this regard, Wang (2020) highlighted that finance was considered from the standpoint of solving two problems: climate change in the right direction and adaptation of the production and household system to climate change.

The impact of green finance on climate change is being actively studied. Recently, Policymakers and academics are examining the scope and impact of COVID-19's impact on the financial industry and its involvement in post-pandemic economic and environment recovery. However, the link between climate change and the current pandemic in light of the development of green finance is a new topic (Klioutchnikov and Kliuchnikov, 2021).

In the baseline scenario of post-pandemic, the key condition for development includes investments in long-term human health, environment and green economy (Wyns, 2020). Green finance plays a leading role in creating measures to preserve the environment and the sustainability of the economy, and in the new conditions in providing epidemiological measures to protect humans, which is extremely important for the effective reproduction of human capital[10]. The green focus of post-pandemic economic recovery will increase the resilience of society to pandemics and other emergencies, including climate change (Cox and Piccolo, 2020).

Under the influence of the pandemic, many problems in the economy and finance have worsened significantly (Ngare et al., 2022). It is widely believed that it is precisely the green focus of financial investment after the pandemic that will open up new prospects for sustainable growth, reduce the threat to society from climate change and create millions of additional jobs in the coming decades (Adom and Amoani, 2021). Guerriero et al. (2020) claimed that financial analysts have observed that epidemiological methods of studying disease incidence and prevalence are well-suited for assessing financial risk and for building models that can analyze green inclusions in finance and economics. Thus, the green focus of finance in the post-pandemic business cycle will to a certain extent become a predictive function (Desalegn and Tangl, 2022).

Climate change and their impacts around the world will threaten businesses in a variety of ways (Watkiss, 2020). Thus, during the pandemic, global CO2 emissions decreased and living conditions in large cities and industrial centers improved. This is an improvement in air quality due to a reduction in traffic. Declines in air pollution in many countries, linked to the economic slowdown caused by the virus outbreak (Dutta et al., 2021).

3. GREEN FINANCE AND CLIMATE CHANGE: AN INSIGHT FROM EGYPT

Egypt is one of the least emitter countries, the current level of CO2 emissions in Egypt is 0.67% which is far lower than the world average[11]. It is noted that climate change adaptation and mitigation actions would require a total estimated cost of about $73 billion over the 2020–2030 period (IMF, 2023). Which emphasized the importance of mobilizing international financial support and technical assistance (UNFCCC, 2022).

The basic tools for green finance in Egypt are: Public Private Partnership PPP[12], Green Bond and Blended Finance[13]. As of September 2020, Egypt issued the first sovereign green bond

8. Therefore, this subject mixes uncertainty, risk, prioritizing ethical choices and international coordination for the common good.
9. The key is: It is ended up with an abatement cost of about 1% of world GDP, which seems to be a reasonable insurance cost.
10. Even small changes in the behavior of people, companies, governments, and investors can have a significant impact on the state of green finance.
11. See: World Bank Data C02 Emissions, Egypt.
12. Fifty-five projects for a total of $10.3 billion in total have reached final closure since 1990. The largest project was the Suez Canal Container Terminal, with its financial closure in 2000 totaling $893.9 million. The most recent project finalized was West Bakr Wind Farm, with its financial closure in 2019 $35 million. 53 projects are under construction or operation for an estimated outstanding of $3.5 billion. (see: PPP Knowledge Lab, Egypt, 1 September 2021)
13. Based on Multilateral Development Banks (MDB's) and Development Finance (DFI's) reports, the estimated amount of MDB/DFI outstanding loans is approximately $27.9 billion (IFC, 2020)

offering in the Middle East and North Africa, with a value of $750 million for 5 years at a yield of 5.25%, putting it on the map of sustainable financing. Egypt had a portfolio of anti-pollution and renewable energy projects worth $1.9 billion (Bloomberg, 2020)[14].

Egypt has identified $1.9 billion for green projects eligible to be financed with Green Bond future issuances. $564.46 million has been disbursed towards these projects to date supported by the 2020 Green Bond (MoF, 2021). Egypt is targeting $7 billion in debt sales (IMF, 2021)[15]. However, Debt market total issuance 2007-2021 is $276 billion (World Bank, 2022d), while sustainable bond issuance is $850 million for the same time period (IFC, 2022)[16].

According to the World Bank report, there are potential opportunities in many sectors in Egypt, at the top of the list are energy and transport seeking reduction of climate change. However, it is expected that Egypt will face a significant financing gap between 2018 and 2038, estimated to be at least $230 billion (World Bank, 2022c). During this period, the estimated financing capacity for the Government could reach $445 billion, while the total needed for infrastructure investments would be approximately $675 billion (OECD, 2018b). Infrastructure investment in Egypt has been declining without a corresponding rise in private investments (World Bank, 2021).

Egypt is working on increasing the supply of electricity generated from renewable sources to 20% by 2022 and 42% by 2035 (IMF, 2021). Its strategy is supported by an ambitious action plan for green hydrogen production that the government is devising in 2022 (World Bank, 2022a). The financing of those projects is one of the main challenges to the transition to clean energy in the country (United Nations, 2020). This financing shortfall represents a potential opportunity for real economy companies to issue sustainable bonds to fund clean energy projects (IFC, 2020)[17].

In addition, the Government of Egypt approved the National Climate Change Strategy 2050 (NCCS), which marks an important step for Egypt's climate policy, laying down priorities for action in mitigation and adaptation, supported by enabling goals on regulatory, financing, technology and capacity constraints.[18]. Egypt is developing a national green taxonomy to identify green assets more easily and undertake a budget tagging exercise to align its public budget with commitments to national sustainable development priorities and the Paris Agreement[19], the plans outline the government's desire to weave sustainability and green projects into every facet of the environment (World Bank, 2020)[20].

4. DATA AND METHODOLOGY

This study is an attempt to examine the linkage between finance and ecology. Environmental sustainability can be attained by arranging funds for solar energy (Camana et al., 2021; Zhou et al., 2020). Green finance was found to be the most effective method of reducing environmental degradation in a study by Chishti and Sinha (2022). Investing in renewable energy is one way that sustainable finance (or green finance) promotes new technology and innovation (Ansari et al., 2022). In order to assess the nexus between green finance on climate change in Egypt the analysis proceeds in two steps: measure the green finance, and then evaluate its impact on climate change for the time span from 1990 to 2021. In what follows, the definitions and sources of data used in the empirical evaluation are described.

In order to achieve a green economy, it is encouraged to build a green finance system (Pereira da Silva, 2016). As also recommended by MacAskill et al. (2020), to promote long-term sustainable growth, it is recommended to establish a green financing system. Green finance is a rapidly growing sector, reshaping the financial system (Alemzero et al., 2020a; 2020b). The consequences of green finance system are not the same in numerous countries and are affected by a wide variety of diverse factors. Studying green finance in Egypt is offering a novel insight to achieve the sustainable development goals.

4.1. Measuring Green Finance

Green bonds are increasingly being used as a measure for green finance, it provides long-term financing of environmental projects. Green bonds are long-term investments that benefit the environment while providing a regular income (Agyekum et al., 2021)[21]. Because green bond is recently issued in Egypt, data is insufficient to run the econometric time-series model. Therefore, this study builds a green finance index (GFI) that covers four elements as recommended by OECD (2017). In order to quantify green finance in Egypt over the time span from 1990 to 2021 more objectively and thoroughly, generalized form of Principle Component Analysis (GPCA) is used because Classical PCA can be used only for cross-sectional data and is not suitable for dynamic analysis. In contrast, the GPCA method, which combines PCA and time series analysis, can analyze time series data and explore the trajectory of the overall level of a system over all time. GFI is explained as follows:

14. The government issued more green bonds in 2022 as part of stepping up its efforts to add more green energy capacities in line with the UN Climate Change Conference of Parties COP27 in November 2022 hosted in Sharm el-Sheikh.
15. There are additional plans to offer the country's first sukuk, or Islamic bonds, in both local and international markets World Bank, (2022b).
16. See: Bloomberg and Environmental Finance Data – date range 2007-2021.
17. The magnitude of the gap in Africa to meet with the SDGs, this gap is estimated to be a yearly $1.3 trillion investment gap, with only 15% of the needs currently met (UNEP, 2018).
18. Please see: Egypt Vision 2030, The Green Growth Knowledge.
19. The Government participated in the launch of the ESCWA climate/ SDG debt swap initiative, which aimed to support debt relief efforts and improve climate finance in middle-income countries in the Arab region that are facing increasing debt burdens, growing SDG related needs and heightened risks in the wake of COVID-19 and its impact on debt trajectories. Efforts in this regard are still progressing and must be intensified to close SDG financing gaps (ESCWA, 2020).
20. The Ministry of Planning and Economic Development and Ministry of Environment have designed and implemented the Environmental Sustainability Guidelines to ensure the greening of the national budget. Under these criteria, 15% of the projects funded from the public budget under the national investment plan of the physical year 2020–2021 are green projects. The government wants to double that target (reaching the 30% of the national investment plan) for the year 2021/2022 is aiming to reach 50% of green projects by the year 2024/2025 (MPED, 2021).
21. These bonds typically come with tax advantages to encourage adoption and bridge the green funding gap. Shareholders prefer green bonds because they can increase the company's long-term value. However, numerous practical micro and meso level difficulties persist (Zhang et al., 2021).

$$GFI_j = W_{j1}X_1 + W_{j2}X_2 + \ldots + W_{jp}X_{pt} \quad (1)$$

Where *GFIj* is the Green Finance Index; *Wj* is the weight on factor score coefficient; p indicators related to green finance X_j (j = 1, 2,…, p). Suppose that there is a total of t years, and X_1, X_2,…, X_t are lined in order to construct index for green finance. With reference to availability of data, selected indicators are shown in Table 1 below.

Two diagnostic tests are conducted for Exploratory Factor Analysis (EFA), Kaiser-Meyer-Olkin (KMO) test and Bartlett's test to determine whether the data can be analyzed using the GPCA method, results are shown in Table 2. The result of the KMO test is 0.781 (>0.5), which indicates that there is a strong correlation among test indicators. The approximate chi square of Bartlett's test is 1047.482 and the significance level is 0.00 (<0.01), indicating that the result rejects the null hypothesis. Therefore, the data can be analyzed using the GPCA method.

4.2. Regression and Variables Selection

This study employs regression analysis to determine the impact of green finance on a climate change and environmental sustainability taking into account data availability and validity. As explained in Table 3, the dependent variable is GHG emissions which specifies the overall quality and herby used as a proxy for climate change. While a high degree of GHG emissions denotes ecological degradation, the absence or low level of GHG emissions denotes improved environmental quality.

In addition, the primary independent variable in this analysis is green finance, which is denoted as (GF). It is significant because it fosters and cares for the drift of financial tools and associated facilities toward formulating and implementing sustainable investment, economic, trade, social and environmental initiatives and regulations. To facilitate the creation and implementation of financial tools and allied services, the green finance variable is crucial. As a result, green finance would have an impact on economic activities and contributes to the country's ecological performance.

Furthermore, the flow of financial instruments is a factor that is highly dependent on the country's economic conditions. Because of this, Mastini et al., (2021) claimed that Gross Domestic Product (GDP) could be an effective factor for presenting a country's economic situation because it measures health and size over a particular period of time. It considers aggregate investment, consumption, production, and other macroeconomic variables to determine the health of an economy. As a result, a high degree of GDP could stimulate financial activity, which would, in turn, consume more natural resources and energy, potentially having a negative influence on the environment.

On the other hand, this study integrates other control variable in the model which is research and development investment (R&D). Throughout the world R&D investment has advanced at a rapid pace since 1990, both in developing and developed countries. This advancement accelerates the rate of production and other economic activities, allowing for achieving higher economic goals. However, as a result of its rapid industrial development, countries such as USA and China have risen to become the world's leading carbon emitter and energy importer, making significant contributions to global warming and climate change. As claimed by Tang et al. (2022) and Zhang et al. (2021), China has concentrated on the growth of green finance to combat the potentially catastrophic issue of climate change and global warming. To fully recognize this connection, it is necessary to look back over the last three decades. To advance green innovation and green development, R&D investment is essential. This has been proven to have threshold effect. Consequently, the threshold variable is the ratio of R&D internal spending to GDP, which represents R&D investment.

Studies such as Wen et al. (2022), Ahmad et al. (2021), Irfan et al. (2021), Gao and Yu (2020), Yang and Ren (2020) and others, showed that an increase in population (POP) leads to an increase in CO2 emissions. Therefore, this study is exploring the impact of population growth on environmental degradation.

According to descriptive statistic results as highlighted in Table 4 and data trends as shown in Figure 1a-d, all of the mean values are positive. The average percentage change of GHG emissions is 67 with minimum and maximum values of 1.87% and 118.89% respectively. The mean value of GF is 6 ranging from −2.5 to 2.7. While, the growth rate of GDP has a mean value of around 4 with minimum value of 1.13% and maximum value of 7.16%. Averages of R&D and POP are 0.4 and 2 respectively, where R&D range is 0.78 and POP range is 0.67. As probability values are lower than 0.05 and the Jarque–Bera test results show that distributions of selected variables are not normally distributed at a 1% significance level, Quantile Autoregressive Distributed Lag (QARDL) model can be used for further analysis.

Table 1: Indicators of the Green Finance Index

Indicator Name	Source
Energy Saving	IEA Statistics © OECD/IEA (http://www.iea.org/stats/index.asp) (https://www.iea.org/t&c/termsandconditions)
Environmental Protection Projects Public Private Participation	Investment in Energy Project Database (http://ppi.worldbank.org)
Service Loans	Loans World Bank, Enterprise Surveys (http://www.enterprisesurveys.org/)
Renewable energy	World Bank, Sustainable Energy for All (SE4ALL) database (jointly by the World Bank, IEA, and the Energy Sector Management Assistance Program)

Table 2: Results of the KMO Test and Bartlett's Test

Test Method	Statistics	Results
Kaiser-Mayer-Olkin test	Measure of sampling adequacy	0.781
Bartlett's test of sphericity	Approx. Chi square	1047.482
	Df.	15
	Sig.	0.000

Source: Author's computation

Table 3: Specifications for the variables, units of measurement and data sources

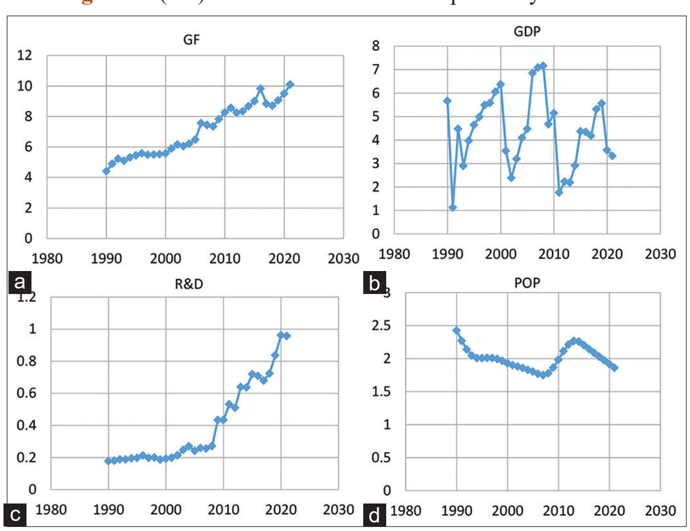
Symbols	Descriptions	Data Sources
GHG (Dependent Variable)	Greenhouse Gas: Total greenhouse gas emissions (% change from 1990)	Climate Watch, GHG Emissions Washington, DC: World Resources Institute (https://www.climatewatchdata.org/ghg-emissions)
GF	Green Finance Index: Energy saving, public private partnership in environment project, service loans and renewable energy	Author's Computation as explained in Table 1
GDP	Gross Domestic Product: GDP growth (annual %)	World Bank national accounts data, and OECD National Accounts data files (https://databank.worldbank.org/source/world-development-indicators)
FDI	Foreign Direct Investment: FDI net inflows (%GDP)	International Monetary Fund, International Financial Statistics and Balance of Payments databases
RDI	Research and Development: Research and development expenditure (% of GDP)	UNESCO Institute for Statistics (http://uis.unesco.org/)
POP	Population: Population growth (annual %)	United Nations Population Division World Population Prospects

Table 4: Descriptive statistics outcomes

Variables	GHG	GF	GDP	R&D	POP
Mean	67.09694	6.25E-11	4.362922	0.401147	2.010588
Maximum	118.9835	2.706119	7.156284	0.96218	2.42666
Minimum	1.874591	−2.511059	1.125405	0.176983	1.751693
Standard Deviation	44.94509	1.969681	1.554709	0.255042	0.167455
Jarque-Bera	37.49479	39.37802	5.78194	46.27398	15.30037
Probability	0	0	0.02	0.03	0
Observations	32	32	32	32	32

Source: Author's preparation using data sources from Table 3

Figure 1: (a-d) Trends of the selected explanatory variables



Source: Author's preparation using data sources from Table 3.

4.3. Model Specification

The QARDL model, developed by Guild (2020) which is a more advanced version of the ARDL model. This model can test green finance, economic growth, R&D and population for their long-term equilibrium effect on GHG emissions. The Wald test is used to examine the stability of integrating coefficients across the quantiles in the time-varying integration connection. Analyzing long and short-run symmetries will be easier with this method. This can be explained by the following model:

$$GHG_t = \mu + \sum_{i=1}^{p} \partial_i GHG_{t-1} + \sum_{i=0}^{q} \theta_i GF_{t-1} + \sum_{i=0}^{r} k_i GDP_{t-1} + \sum_{i=0}^{s} \omega_i R\&D_{t-1} + \sum_{i=0}^{u} \psi_i POP_{t-1} + \varepsilon_t \quad (2)$$

Where ε_t represents the error term explained as GHG_t – E $[S/\gamma_{t-1}]$, γ_{t-1} being the smallest σ-field generated by (GHG_t, GF_t, GDP_t, $R\&D_t$, POP_t, GHG_{t-1}, GF_{t-1}, GDP_{t-1}, $R\&D_{t-1}$, POP_{t-1}), and p, q, r, s, and u are lag orders according to Schwarz Information Criteria (SIC). In Equation 2, GHG, GF, GDP, R&D, and POP are GHG emissions, green finance, GDP, R&D, and population respectively.

QARDL (p,q,r,s,u) was proposed by Ingham et al. (2015) as an extension of the model expressed in Equation 2:

$$Q_{GHGt} = \mu(\tau) + \sum_{i=1}^{p} \partial_i(\tau) GHG_{t-1} + \sum_{i=0}^{q} \theta_i(\tau) GF_{t-1} + \sum_{i=0}^{r} k_i(\tau) GDP_{t-1} + \sum_{i=0}^{s} \omega_i(\tau) R\&D_{t-1} + \sum_{i=0}^{u} \psi_i(\tau) POP_{t-1} + \varepsilon_t(\tau) \quad (3)$$

Where $\varepsilon_t(\tau)$ = GHGt – $Q_{GHGt}(\tau/\delta_{t-1})$ and $0 > \tau < 1$ is showing a quantile. The QARDL model shown in equation 3 is simplified as follows because of the possibility of serial correlation:

$$Q_{\Delta GHGt} = \mu + \rho GHG_{t-1} + \phi_{GF} GF_{t-1} + \phi_{GDP} GDP_{t-1} + \phi_{R\&D} R\&D_{t-1} + \phi_{POP} POP_{t-1} + \sum_{i=1}^{p-1} \partial_i \Delta GHG_{t-1} + \sum_{i=0}^{q-1} \theta_i \Delta GF_{t-1} + \sum_{i=0}^{r-1} k_i \Delta GDP_{t-1} + \sum_{i=0}^{s-1} \omega_i \Delta R\&D_{t-1} + \sum_{i=0}^{u-1} \psi_i \Delta POP_{t-1} + \varepsilon_t(\tau) \quad (4)$$

Equation 5, which depicts the QARDL-ECM model, is reformulated as follows:

$$Q_{\Delta GHGt} = \mu(\tau) + \rho(\tau)(GHG_{t-1} - \beta_{GF} GF_{t-1} - \beta_{GF\,GDP} GDP_{t-1} - \beta_{R\&D} R\&D_{t-1} - \beta_{POP} POP_{t-1}) + \sum_{i=1}^{p-1} \partial_i(\tau) \Delta GHG_{t-1} + \sum_{i=0}^{q-1} \theta_i(\tau) \Delta GF_{t-1} + \sum_{i=0}^{r-1} k_i(\tau) \Delta GDP_{t-1} + \sum_{i=0}^{s-1} \omega_i(\tau) \Delta R\&D_{t-1} + \sum_{i=0}^{u-1} \psi_i(\tau) \Delta POP_{t-1} + \varepsilon_t(\tau) \quad (5)$$

The short-term influence on GHG emissions of all previous changes can be calculated using the delta approach given by:

$$\partial_* = \sum_{i-1}^{p-1} \partial \partial_j$$

while the collective short-term influence of the earlier and current levels of GHG, GF, GDP, R&D, and POP is determined by:

$$\theta_* = \sum_{i-1}^{q-1} \partial \theta_j, \quad k_* = \sum_{i-1}^{r-1} \partial k_j, \quad \omega_* = \sum_{i-1}^{s-1} \partial \omega_j \quad \text{and} \quad \psi_* = \sum_{i-1}^{u-1} \partial \psi_j$$

respectively.

The parameter associated with the long-run for GF, GDP, R&D and POP is calculated as follows:

$$\beta_{GF*} = \frac{\beta_{GF}}{\rho}, \quad \beta_{GDP*} = \frac{\beta_{GDP}}{\rho}, \quad \beta_{R\&D*} = \frac{\beta_{R\&D}}{\rho} \quad \text{and} \quad \beta_{POP*} = \frac{\beta_{POP}}{\rho}$$

5. RESULTS AND DISCUSSION

This part presents the main results and findings of the work. Initially unit root test is carried out to investigate the stationarity of the data. Afterworlds, Quantile Regression is implemented and analyzed.

5.1. Unit Root Test

The Unit Root test (Im et al., 2003) is conducted, using Augmented Dickey–Fuller (ADF) test and Phillips-Perron (PP) test to identify the root of the problem. Variables are tested in both level and 1st difference forms, with intercept and with intercept and time trend. The findings of the ADF and PP unit root tests are presented in Tables 5 and 6. According to the results of the ADF and PP tests, all variables were nonstationary at the level form except GDP. ADF and PP tests results strongly reject the null hypothesis of a unit root (variables are stationary) for 1st difference, as the absolute value of t-statistics is higher than critical values at 5% level and P<5%. While results at level form, both with intercept and with intercept and time trend were insignificant at 5% level so that data is integrated to order (1).

5.2. Quantile Regression Analysis

As claimed by Cade and Noon (2003), in ecology, quantile regression has been proposed and used as a way to discover more useful predictive relationships between variables in cases where there is no relationship or only a weak relationship between the means of such variables. The need for and success of quantile regression in ecology has been attributed to the complexity of interactions between different factors leading to data with unequal variation of one variable for different ranges of another variable. To run quantile regression model, two diagnostic tests should be conducted, correlation test and heteroscedasticity test.

According to the results of Breusch-Godfrey Serial Correlation LM test, the Obs*R-squared and with respect to Prob. Chi-square value is less than 0.05, which denotes that residuals are serially correlates as expressed in Table 7.

On the other hand, result of Breusch-Pagan-Godfrey Heteroscedasticity test shows that the Obs*R-squared and with respect to Prob. Chi-Square value is less than 0.05, which implies that residuals are far from heteroscedasticity (Table 8). In this situation quantile regression should be employed.

Presented in Table 9 results of Quantile Regression (Median), which indicate that the estimated coefficient is statistically significant at the negative level for green finance and R&D, while statistically significant at the positive level for population and statistically insignificant for economic growth. Prob(Quasi-LR stat) is <5% which means the model is stable. With every 1% increase in the median value of green finance, leads to 0.2% decrease in GHG emissions.

According to this study the estimated equation quantile tau is 0.5 and the specified number of process quantiles is 10. Based on the quantile process estimates as presented in Figure 2, the estimated coefficient is statistically significant at all quantiles which implies a long-term equilibrium between GHG emissions and other variables, such as green finance, economic growth, R&D and population. The cointegration of the main explanatory variable which is green finance is significant with a negative sign at all quantiles except for quantiles 0.10, 0.20 and 0.30. Green finance coefficient is steadily increasing except for quantile 0.70, however, the speed of adjustment is fast. This finding highlights

Table 5: ADF test statistics

Variables	At level				At 1st difference			
	Intercept		Intercept + Time Trend		Intercept		Intercept + Time Trend	
	t-Statistics	Prob.*	t-Statistics	Prob.*	t-Statistics	Prob.*	t-Statistics	Prob.*
GHG	−1.274	0.628	−0.130	0.991	−3.579	0.012*	−3.742	0.034*
GF	0.050	0.956	−2.377	0.383	−4.932	0.000*	−4.844	0.002*
GDP	−3.295	0.023*	−4.182	0.012*	−8.073	0.000*	−8.046	0.000*
R&D	1.481	0.998	−1.143	0.904	−5.780	0.000*	−7.002	0.000*
POP	−2.111	0.242	−3.531	0.058	−8.073	0.000*	−8.086	0.000*

Source: Author's estimation (statistical work is performed using E-views software version 12). *Denotes result is significant at 5% level

Table 6: PP test statistics

Variables	At level				At 1st difference			
	Intercept		Intercept + Time trend		Intercept		Intercept + Time trend	
	t-Statistics	Prob.*	t-Statistics	Prob.*	t-Statistics	Prob.*	t-Statistics	Prob.*
GHG	−0.923	0.767	−0.922	0.940	−3.648	0.010*	−3.727	0.031*
GF	0.012	0.952	−2.422	0.361	−4.923	0.000*	−4.831	0.001*
GDP	−3.295	0.023*	−3.237	0.049*	−8.073	0.000*	−7.728	0.000*
R&D	3.262	1.000	−0.409	0.982	−5.778	0.000*	−11.684	0.001*
POP	−2.627	0.098	−2.548	0.304	−3.436	0.014*	−3.513	0.008*

Source: Author's estimation (statistical work is performed using E-views software version 12). *Denotes result is significant at 5% level.

Table 7: Results of Breusch-Godfrey Serial Correlation LM Test

Breusch-Godfrey Serial Correlation LM Test			
F-statistic	5.967566	Prob. F (2,25)	0.0076
Obs*R-squared	10.34040	Prob. Chi-square (2)	0.0057

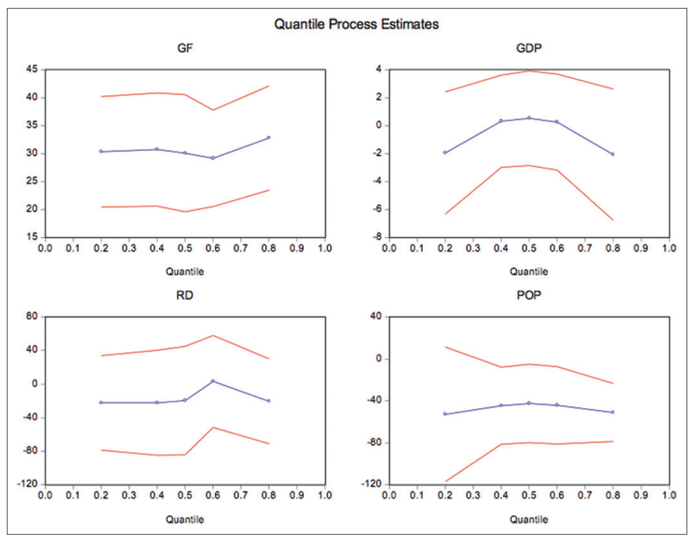
Source: Author's estimation (statistical work is performed using E-views software version 12)

Table 8: Results of Breusch-Pagan-Godfrey Heteroscedasticity Test

Heteroskedasticity Test: Breusch-Pagan-Godfrey			
F-statistic	4.886683	Prob. F (4,27)	0.0043
Obs*R-squared	13.43801	Prob. Chi-Square (4)	0.0093
Scaled explained SS	8.037825	Prob. Chi-Square (4)	0.0902

Source: Author's estimation (statistical work is performed using E-views software version 12)

Figure 2: Quantile process estimates



Source: Author's preparation (statistical work is performed using E-views software version12).

the long-run inverse association between GHG emissions and green finance. The strong correlation between the two variables predicts that a 1% increase in green finance will result in a 0.2% decrease in GHG emissions. This result is consistent with Alola et al. (2022), Tang et al. (2022), Chen and Chen (2021), Iqbal et al. (2021), Sun et al. (2021), Zheng et al. (2021), Zhou et al. (2020), Wang and Zhi (2016) and others, they discovered an opposite relationship between green finance and CO2 emissions, signifying that increasing concept of green finance reduces CO2 emissions. On the other hand, opposing these results, Fu et al. (2021) revealed that green finance does not influence CO2 emissions.

Unlike the results obtained from most researches, the cointegration parameter for economic growth in terms of GDP is positive but insignificant for all quantiles, which points out that growth is not seen as a determinant of emissions in Egypt. However, this result is consistent with Bodin (2022), Abdulmalik et al. (2020) and Alam et al. (2016), their results show insignificant evidence to support the existence of long-term relationship between economic growth and environment degradation among sample countries. In a conclusion, GDP positively impacts GHG emissions but statistically insignificant in Egypt, indicating that it does not represent an effective component for climate change. This could be justified by an increase in GDP is not accompanied by an increase in the country's primary production components and also because agribusiness is a major component of the Egyptian economy, contributing 11.3% to GDP[22]. GDP is not a significant long-term driver of CO2 emissions, as previously proposed by Khan et al. (2022).

On the contrary, there exists a strong long-run inverse relationship between R&D and GHG emissions but only for the medium and upper terms quantiles (0.5–0.9). This finding is in line with the immediate roadmap that proposed "towards an operative taxonomy

22. See: Agriculture and Food Security Egypt, U.S. Agency for International Development (USAID), July 2020.

Table 9: Results of Quantile Regression (Median)

Dependent Variable: GHG Method: Quantile Regression (Median) Sample: 1990 2021 Included observations: 32 Huber Sandwich Standard Errors and Covariance Sparsity method: Kernel (Epanechnikov) using residuals Bandwidth method: Hall-Sheather, bw=0.30602 Estimation successfully identifies unique optimal solution				
Variable	**Coefficient**	**Standard error**	**t-statistic**	**Prob.**
C	8.967915	2.189273	3.215144	0.0000
GF	−0.219048	0.063112	−3.469081	0.0000
GDP	0.543791	1.569110	0.346560	0.7316
RD	−1.692262	0.761449	−2.222421	0.0348
POP	4.098682	0.874063	4.689229	0.0001
Pseudo R-squared	0.868282	Mean dependent variable		67.09694
Adjusted R-squared	0.848768	S.D. dependent variable		44.94509
S.E. of regression	8.144475	Objective		85.90044
Quantile dependent var	75.25999	Restr. objective		652.1522
Sparsity	23.64943	Quasi-LR statistic		191.5486
Prob (Quasi-LR stat)	0.000000			

Source: Author's estimation (statistical work is performed using E-views software version 12)

Table 10: Results of Quantile Slope Equality Test

Quantile Slope Equality Test Equation: UNTITLED Specification: GHG GF GDP RD POP C Estimated equation quantile tau=0.5 Number of test quantiles: 10 Test statistic compares all coefficients			
Test Summary	**Chi-square statistic**	**Chi-square d.f.**	**Prob.**
Wald test	29.758789	14	0.0195

Source: Author's estimation (statistical work is performed using E-views software version 12).

Table 11: Results of Symmetric Quantiles Test

Symmetric Quantiles Test Equation: UNTITLED Specification: GHG GF GDP RD POP C Estimated equation quantile tau=0.5 Number of test quantiles: 10 Test statistic compares all coefficients			
Test Summary	**Chi-square statistic**	**Chi-square d.f.**	**Prob.**
Wald Test	9.544477	20	0.9757

Source: Author's estimation (statistical work is performed using E-views software version 12).

for climate finance" which focused on implementation, the long-term roadmap by investing more on R&D to upscale green finance for environment sustainability (UNEP, 2022). This is coherent with many studies that emphasize that R&D leads to significant opposite impact on climate change, amongst Jiang and Khattak (2023), Liu et al. (2022), Xin et al. (2022), Petrović and Lobanov (2020), Luan et al. (2019) and others.

In addition, the cointegration coefficient for the association between population growth and GHG emissions in Egypt is significant specially for the lowest quantiles 0.10 and 0.20 and flashed with a positive sign at all quantiles. Which proves that higher population can result in GHG emissions. The result is aligned with the expectation about population growth in Egypt, as it is well above natural birth replacement levels and is expected to double by 2078[23]. The current finding could make a contribution to the existing body of literature, alongside the contributions made by Bellon and Massetti (2022), Kirby and Mainuddin (2022), Budolfson and Spears (2020), Dodson et al. (2020), Nugent (2019), Scovronick et al. (2017), UNFPA (2011) and Satterthwaite (2009).

5.3. Quantile Slope Equality Test

Wald test is used to explore whether the parameters remain constant across all quantiles. It emphasizes the nonlinearities in both short-run and long-run parameters. According to results of Wald test presented in Table 10, the Chi-sqaure Statistic value of Quantile Slope Equality test is statistically significant, this denotes to reject the slope equality hypothesis at 5% significance level, which means that slope equality is different across quantile levels. However, the inter quantile range could not reject the null hypothesis at 5% significance level, implying that slope equality does not differ.

5.4. Symmetric Quantiles Test

With respect to Wald test results, the Chi-square Statistic value of Symmetric Quantiles Test is 9.54 which is statistically insignificant. There is an evidence of symmetry as the P=0.97. The individual coefficient restriction test values show no evidence across the quantiles 0.10 and 0.8 (Table 11).

6. CONCLUSION

Environmental degradation is one of the most pressing issues facing the world today, and it affects both developing and developed countries. Several nations are vigorously engaged in

23. See: Egypt Population 2022, World Population Review.

developing environmental protection policies and programs. In the background of economic development and growth, ecological degradation turns out to be even more serious as economic growth has the potential to have negative consequences for the environment. In this paper GHG emissions is used as a proxy for investigating climate change. To consolidate the determinants of GHG emissions, there are some variables to consider. For this reason, and due to the importance of the variables described above to the environment, QARDL model has been used to analyze the impact of green finance, economic growth, investment on R&D and population growth on GHG emissions from 1990 to 2021 in Egypt.

According to the study results green finance improves the Egyptian ecosystem. R&D has both significant and negative impact on GHG emissions, meaning that improvements in R&D investment is straight forwardly related to enhancements in ecological situations. In the short term, dynamics reveal that population variations are significantly and positively affect emissions. In contrast, GDP is positive but statistically insignificant. Nonetheless, the argument for a carbon-free future is based on using a negative emission sources until a significant proportion of renewable energy is included in the energy mix and upgrade/construct infrastructure in the energy sector. In the same way, a commitment should be noted to a gradual trade-off between traditional energy sources and the achievement of net zero-emissions energy sources. As a result, financial instruments must be implemented to gradually incentivizing policies to attract investment in green finance within the public and private sectors.

Based on the above findings, the following policies are recommended; promote the development of green finance, improve the green financial system, support the green, ecological and low carbon industries and give priority to green activities and clean renewable energy sources.

REFERENCES

Abdulmalik, M.Y., Attahir, B.A., Suleiman, O.M. (2022), Relationship between greenhouse gas emission, energy consumption, and economic growth: Evidence from some selected oil-producing African Countries. Environmental Science and Pollution Research, 27, 15815-15823.

Adom, P.K., Amoani, S. (2021), The role of climate adaptation readiness in economic growth and climate change relationship: An analysis of the output/income and productivity/institution channels. Journal of Environmental Management, 293, 112-123.

Agyekum, E.B., Amjad, F., Mohsin, M., Ansah, M.S. (2021), A bird's eye view of Ghana's renewable energy sector environment: A multi-criteria decision-making approach. Utilities Policy, 70, 101219.

Ahmad, M., Akhtar, N., Jabeen, G., Irfan, M., Anser, M.K., Wu, H., Isek, C. (2021), Intention-based critical factors affecting willingness to adopt novel coronavirus prevention in Pakistan: Implications for future pandemics. International Journal of Environmental Research and Public Health, 18, 61-67.

Akomea-Frimpong, I., Adeabah, D., Ofosu, D., Tenakwah, E. (2021), A review of studies on green finance of banks, research gaps and future directions. Journal of Sustainable Finance and Investment, 12(4), 1241-1264.

Alam, M.M., Murad, M.W., Noman, A.H.M., Ozturk, I. (2016), Relationships among carbon emissions, economic growth, energy consumption and population growth: Testing environmental Kuznets Curve Hypothesis for Brazil, China, India and Indonesia. Ecological Indicators, 70, 477-479.

Alemzero, D.A., Iqbal, N., Iqbal, S., Mohsin, M., Chukwuma, N.J., Shah, B.A. (2020a), Assessing the perceived impact of exploration and production of hydrocarbons on household's perspective of environmental regulation in Ghana. Environmental Science Pollution Research and Management, 28, 5359-5371.

Alemzero, D.A., Sun, H., Mohsin, M., Iqbal, N., Nadeem, M., Vo, X.V. (2020b), Assessing energy security in Africa based on multi-dimensional approach of principal composite analysis. Environmental Science Pollution Research and Management, 28, 2158-2171.

Ali, M., Irfan, M., Ozturk, I., Rauf, A. (2022), Modeling public acceptance of renewable energy deployment: A pathway towards green revolution. Economic Research-Ekonomska Istraživanja, 36(1), 1-19.

Alola, A.A., Alola, U.V., Akdag, S., Yildirim, H. (2022), The role of economic freedom and clean energy in environmental sustainability: Implication for the G-20 economies. Environmental Science and Pollution Research, 29, 36608-36615.

Ansari, M.A., Haider, S., Kumar, P., Kumar, S., Akram, V. (2022), Main determinants for ecological footprint: An econometric perspective from G20 countries. Energy, Ecology and Environment, 7, 250-267.

Arkhipova, V. (2017), Green finance as recipe for solving global problems. HSE Economic Journal, 21(2), 312-332.

Bellon, M., Massetti, E. (2022), Economic Principles for Integrating Adaptation to Climate Change into Fiscal Policy. IMF Staff Climate Note 2022/001. Washington, D.C.: International Monetary Fund.

BIS (Bank for International Settlements). (2017), 87th Annual Report, June 2017, Chapter VI. Available from: www.bis.org/publ/arpdf/ar2017e6.htm

Bloomberg. (2020), Middle East's First Sovereign Green Bond Sees Strong Demand. Bloomberg Terminal and Bloomberg NEF. United States: Bloomberg. Available from: https://www.bloomberg.com/news/articles/2020-09-29/egypt-offers-the-middle-east-s-first-sovereign-green-bond

Bodin, A. (2022), The Relationship between Economic Growth and Environmental Degradation: Comparing the Environmental Kuznets Curve in European Countries: Bachelor Thesis in National Economics, 15 HP National Economics C100:2, UMEÅ Universitet.

Bodnar, P., Ott, C., Edwards, R., Hoch, S., McGlynn, E.F., Wagner, G. (2018), Underwriting 1.5°C: competitive approaches to financing accelerated climate change mitigation. Climate Policy, 18, 368-382.

Budolfson, M., Spears, D. (2020), Population momentum, population ethics, and the prospects for fertility policy as climate mitigation policy. In: Bowman, P., Rasmussen, B.K., editors. Study on Climate Ethics and Future. Vol. 2. Stockholm: Institute for Futures Studies Working Paper Series. p199-217.

Cade, B.S., Noon, B.R. (2003), A gentle introduction to quantile regression for ecologists. Frontiers in Ecology and the Environment, JSTOR, 1(8), 412-420.

Camana, D., Manzardo, A., Toniolo, S., Gallo, F., Scipioni, A. (2021), Assessing environmental sustainability of local waste management policies in Italy from a circular economy perspective. An overview of existing tools. Sustainable Production and Consumption, 27, 613-629.

Chen, X., Chen, Z. (2021), Can green finance development reduce carbon emissions? Empirical evidence from 30 Chinese provinces. Sustainability, 13, 112137.

Chishti, M.Z., Sinha, A. (2022), Do the shocks in technological and financial innovation influence the environmental quality? Evidence from BRICS economies. Technology in Society, 68, 101828.

Coscieme, L., Mortensen, L.F., Donohue, I. (2021), Enhance environmental policy coherence to meet the sustainable development goals. Journal of Cleaner Production, 296, 126502.

Cox, A., Piccolo, A. (2020), Environmental Health and Strengthening Resilience to Pandemics. Vol. 21. Paris, France: OECD. p2-14.

Dafe, F., Volz, U. (2015), Financing Global Development: The Role of Central Banks. Vol. 8. Bonn: German Development Institute (DIE). p1-4.

Desalegn, G., Tangl, A. (2022), Developing countries in the lead: A bibliometric approach to green finance. Energies, 15(4), 36-44.

Dikau, S., Volz, U. (2021), Central bank mandates, sustainability objectives and the promotion of green finance. Ecological Economics, 184, 107-122.

Dodson, J., Dérer, P., Cafaro, P., Götmark, F. (2020), Population growth and climate change: Addressing the overlooked threat multiplier. Science of the Total Environment, 748, 141346.

Dutta, A., Bouri, E., Noor, M.H. (2021), Climate bond, stock, gold, and oil markets: Dynamic correlations and hedging analyses during the COVID-19 outbreak. Resources Policy, 74, 102-265.

Ehlers, T., Packer, F. (2016), Green bonds-certification, shades of green and environmental risks: Contribution to the G20 green finance study group, Bank of International Settlements Quarterly reviews, 9, 1-11.

ESCWA (United Nations Economic and Social Commission for Western Asia). (2020), Arab Sustainable Development Report 2020. Available from: https://archive.unescwa.org/publications/arab-sustainable-development-report-2020

Fu, F.Y., Alharthi, M., Bhatti, Z., Sun, L., Rasul, F., Hanif, I. (2021), The dynamic role of energy security, energy equity and environmental sustainability in the dilemma of emission reduction and economic growth. Journal of Environmental Management, 280, 111828.

Gao, X., Yu, J. (2020), Public governance mechanism in the prevention and control of the COVID-19: Information, decision-making and execution. Journal of Chinese Governance, 5(4), 178-197.

GCEC (The Global Commission on the Economy and Climate). (2018), Unlocking the Inclusive Growth Story of the 21st Century: Accelerating Climate Action in Urgent Times-new Climate Economy Report. Washington D.C.: World Resources Institute.

Gerlagh, R., Bijgaart, I.V., Nijland, H., Michielsen, T. (2018), Fiscal policy and CO 2 emissions of new passenger cars in the EU. Journal of Environmental and Resource Economics, 69(1), 103-134.

Giglio, S., Maggiori, M., Rao, K., Stroebel, J., Weber, A., Nieuwerburgh, S.V. (2021), Climate change and long-run discount rates: Evidence from real estate. The Review of Financial Studies, 34(8), 3527-3571.

Guerriero, C., Haines, A., Pagano, M. (2020), Health and sustainability in post-pandemic economic policies. Nature Sustainability, 4(3), 1-3.

Guild, J. (2020), The political and institutional constraints on green finance in Indonesia. Journal of Sustainable Finance and Investment, 10(4), 157-170.

He, W., Abbas, Q., Alharthi, M., Mohsin, M., Hanif, I., Vo, X.V., Taghizadeh-Hesary, F. (2020), Integration of renewable hydrogen in light-duty vehicle: Nexus between energy security and low carbon emission resources. International Journal of Hydrogen Energy, 45, 27958-27968.

IEA (International Energy Agency). (2021), Renewables 2021-Analysis and Forecast to 2026. Revised Version. Available from: https://iea.blob.core.windows.net/assets/5ae32253-7409-4f9a-a91d-1493ffb9777a/Renewables2021-Analysisandforecastto2026.pdf

IFC (International Finance Corporation). (2020), Country Private Sector Diagnosis Creating Markets in Egypt. Washington D.C.: World Bank Group. Available from: https://www.ifc.org/wps/wcm/connect/af513599-08b4-45a4-b346-1a44de58cda6/CPSD-Egypt.pdf?MOD=AJPERES&CVID=npT1-BJ

IFC. (2022), Emerging Market Green Bonds Report: Riding the Green Wave. Washington D.C.: World Bank Group. Available from: https://www.ifc.org/wps/wcm/connect/industry_ext_content/ifc_external_corporate_site/financial+institutions/resources/emerging+market+green+bonds+report+2021

Ikram, M., Mahmoudi, A., Shah, S.Z.A., Mohsin, M. (2019), Forecasting number of ISO 14001 certifications of selected countries: Application of even GM (1,1), DGM, and NDGM Models. Environmental Science and Pollution Research, 26, 12505-12521.

Im, K.S., Pesaran, M.H., Shin, Y. (2003), Testing for unit roots in heterogeneous panels. Journal of Economics, 115, 53-74.

IMF (International Monetary Fund). (2021), IMF Executive Board Completes the Second Review Under the Stand-by Arrangement (SBA) for the Arab Republic of Egypt and Concludes 2021 Article IV Consultation. IMF Press Release No. 21/193.

IMF. (2023), Arab Republic of Egypt: Request for Extended Arrangement under the Extended Fund Facility. IMF Country Report No. 23/2.

Ingham, J., Cadieux, J., Mekki Berrada, A. (2015), E-shopping acceptance: A qualitative and meta-analytic review. Information Management, 52, 44-60.

IPCC (Intergovernmental Panel on Climate Change). (2022), Climate Change 2022: Impacts, Adaptation and Vulnerability. Working Group II Contribution to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. Available from: https://report.ipcc.ch/ar6/wg2/IPCC_AR6_WGII_FullReport.pdf

Iqbal, S., Taghizadeh-Hesary, F., Mohsin, M. (2021), Assessing the role of the green finance index in environmental pollution reduction. Studies of Applied Economics, 39(3), 4140.

Irfan, M., Shahid, A.L., Ahmad, M., Iqbal, W., Elavarasan, R.M., Ren, S., Hussain, A. (2021), Assessment of public intention to get vaccination against COVID-19: Evidence from a developing country. Journal of Evaluation in Clinical Practice, 13(6), 1-11.

Jiang, Q., Khattak, S.I. (2023), Modeling the impact of innovation in marine energy generation-related technologies on carbon dioxide emissions in South Korea. Journal of Environmental Management, 326(B), 116-818.

Khan, M., Chaudhry, M.N. (2021), Role of and challenges to environmental impact assessment proponents in Pakistan. Environmental Impact Assessment Review, 90, 106606.

Khan, S.A.R., Godil, D.I., Yu, Z., Abbas, F., Shamim, M.A, (2022), Adoption of renewable energy sources, low-carbon initiatives, and advanced logistical infrastructure-an step toward integrated global progress. Journal of Sustainable Development, 30, 275-288.

Kirby, M., Mainuddin, M. (2022), The impact of climate change, population growth and development on sustainable water security in Bangladesh to 2100. Scientific Reports, 12, 223-244.

Klioutchnikov, I., Kliuchnikov, O. (2021), Green Finance: Pandemic and Climate Change. E3S Web of Conferences 234-00042.

Larsen, B. (2019), Egypt: Cost of Environmental Degradation: Air and Water Pollution. Washington D.C:. World Bank Group. Available from: https://openknowledge.worldbank.org/bitstream/handle/10986/32513/Egypt-Cost-of-Environmental-Degradation-Air-and-Water-Pollution.pdf?sequence=1

Li, X., Ozturk, I., Syed, Q.R., Hafeez, M., Sohail, S. (2022), Does green environmental policy promote renewable energy consumption in BRICST? Fresh insights from panel quantile regression. Economic Research-Ekonomska Istraživanja, 35(1), 5807-5823.

Liu, A., Wu, D.C. (2019), Tourism productivity and economic growth. Annual Tourism Research, 76, 253-265.

Liu, H., Tang, Y.M., Iqbal, W., Raza, H. (2022), Assessing the role of energy finance, green policies, and investment towards green economic recovery. Environmental Science of Pollution Research, 29, 21275-21288.

Liu, H., Yao, P., Wang, X., Huang, J., Yu, L. (2021), Research on the peer behavior of local government green governance based on SECI expansion model. Land, 10(5), 472.

Luan, *B*., Huang, J., Zou, H. (2019), Domestic R&D, technology acquisition, technology assimilation and China's industrial carbon intensity: Evidence from a dynamic panel threshold model. Science of the Total Environment, 693, 133436.

MacAskill, K., O'Hanlon, F., Guthrie, P., Mian, J. (2020), Fostering resilience-oriented thinking in engineering practice. Proceedings of the Institution of Civil Engineers: Engineering Sustainability, 173, 356-364.

Mastini, R., Kallis, G., Hickel, J. (2021), A green new deal without growth? Journal of Ecological Economics, 179, 106832.

Matthews, K.R., Robert, L.W., Murphy, C. (2017), Communicating the deadly consequences of global warming for human heat stress. Proceedings of the National Academy of Sciences USA, 114, 3861-3866.

MoF (Ministry of Finance, Egypt). (2021), Egypt Sovereign Green Bond Allocation and Impact Report. Green Financing Working Group. Available from: https://assets.mof.gov.eg/files/a3362b50-574c-11ec-9145-6f33c8bd6a26.pdf

Mohsin, M., Hanif, I., Taghizadeh-Hesary, F., Abbas, Q., Iqbal, W. (2021), Nexus between energy efficiency and electricity reforms: A DEA-based way forward for clean power development. Energy Policy, 149, 112052.

Moz-Christofoletti, M.A., Pereda, P.C. (2021), Winners and losers: The distributional impacts of a carbon tax in Brazil. Ecological Economics, 183(C), 106945.

MPED (Ministry of Planning and Economic Development, Egypt). (2021), Egypt's 2021 Voluntary National Review. Available from: https://mped.gov.eg/singlenews?id=1046&lang=en

Muchiri, M.K., Erdei-Gally, S., Fekete-Farkas, M., Lakner, Z. (2022), Bibliometric analysis of green finance and climate change in post-Paris agreement era. Journal of Risk and Financial Management, 15, 120-561.

Ngare, I., Gikonyo, S., Njagi, G., Ogutu, E. (2022), Review: Climate change resilience disconnect in rural communities in coastal Kenya. A rhetoric communication discord proliferated by COVID-19 pandemic. Frontiers in Sustainable Food Systems, 9(6), 943181.

Nugent, C. (2019), The 10 Countries Most Vulnerable to Climate Change will Experience Population Booms in the Coming Decades. New York City: Time Magazine. Available from: https://www.populationenvironmentresearch.org/node/10689

OECD (The Organization for Economic Cooperation and Development). (2017), Green Growth Indicators 2017. OECD Green Growth Studies. Available from: https://www.oecd.org/greengrowth/green-growth-indicators-2017-9789264268586-en.htm

OECD. (2018a), Financing Climate Futures: Rethinking Infrastructure Policy Highlights. Available from: https://www.oecd.org/environment/cc/climate-futures/policy-highlights-financing-climate-futures.pdf

OECD. (2018b), Private Sector Engagement through Development Cooperation in Egypt, Country Case Study. Global Partnership for Effective Development Cooperation. Available from: https://www.oecd.org/dac/effectiveness/PSE-case-study-Egypt.pdf

Pawar, P., Wu, X. (2021), Green building policies in cities: A comparative assessment and analysis. Energy Build, 231, 110561.

Pereira da Silva, L. (2016), Rethinking Development Finance: Towards a New 'Possible Trinity' for Growth? Remarks at the Atlantic Dialogues 2016. Marrakesh: BIS (Bank for International Settlements). Available from: http://www.bis.org/speeches/sp170221.htm

Petrović, P., Lobanov, M.M. (2020), The Impact of R&D expenditures on CO_2 emissions: Evidence from sixteen OECD Countries. Journal of Cleaner Production, 248(1), 119187.

Sachs, D., Woo, W.T., Yoshino, N., Taghizadeh-Hesary, F. (2019), Why is Green Finance Important? ADBI Working Paper Series No. 917.

Saint, S., Tomiwa, A., Adebayo, S. (2021), Asymmetric nexus among financial globalization, non-renewable energy, renewable energy use, economic growth and carbon emissions: Impact on environmental sustainability targets in India. Environmental Science and Pollution Research, 29, 16311-16323.

Sarker, P.K., Bouri, E., Marco, C.K. (2022), Asymmetric effects of climate policy uncertainty, geopolitical risk, and crude oil prices on clean energy prices. Environmental Science and Pollution Research, 30(6), 15797-15807.

Satterthwaite, D. (2009), The implications of population growth and urbanization for climate change. Environment and Urbanization, 21(2), 545-567.

Scovronick, N., Budolfson, M.B., Dennig, F., Fleurbaey, M., Siebert, A., Socolow, R.H., Spear, D., Wagner, F. (2017), Impact of population growth and population ethics on climate change mitigation policy. Proceedings of the National Academy of Sciences of the United States of America (PNAS), 114(46), 2338-2343.

Sen, S., Schickfus, M.T. (2020), Climate policy, stranded assets, and investors' expectations. Journal of Environmental Economics and Management, 100(C), 102277.

Shah, S.A., Zhou, P., Walasai, G.D., Mohsin, M. (2019), Energy security and environmental sustainability index of South Asian countries: A composite index approach. Ecological Indicators, 106, 105507.

Stern, N. (2008), The economics of climate change. American Economic Review, 98(2), 1-37.

Sun, H., Pofoura, A.K., Adjei Mensah, I., Li, L., Mohsin, M. (2020), The role of environmental entrepreneurship for sustainable development: Evidence from 35 countries in Sub-Saharan Africa. Science of Total Environment, 741, 140132.

Sun, Y., Li, H., Zhang, K., Kamran, H.W. (2021), Dynamic and casual association between green investment, clean energy and environmental sustainability using advance quantile A.R.D.L. Framework. Economic Research-Ekonomska Istrazivanja, 35, 1997627.

Tang, Y.M., Chau, K.Y., Fatima, A., Waqas, M. (2022), Industry 4.0 technology and circular economy practices: Business management strategies for environmental sustainability. Environmental Science Pollution Research and Management, 29(33), 49752-49769.

Tiep, N.C., Wang, M., Mohsin, M., Kamran, H.W., Yazdi, F.A. (2021), An assessment of power sector reforms and utility performance to strengthen consumer self-confidence towards private investment. Journal of Economic Analysis and Policy, 69, 676-689.

UNEP (United Nations Environment Program). (2017), On the Role of Central Banks in Enhancing Green Financing. Inquiry Working Paper 17/01. Available from: https://www.unep.org/ar/node/8951

UNEP. (2018), Rethinking Impact to Finance the SDGs: A Position Paper and Call to Action Prepared by the Positive Impact Initiative, UNEP Finance Initiative. Available from: https://www.unepfi.org/publications/rethinking-impact-to-finance-the-sdgs-a-position-paper-and-call-to-action

UNEP. (2022), A New Approach Unlocking Private Finance for Climate and the SDGs in Egypt and Morocco: Conclusions and Roadmap Resulting from the Reflective Cycle. UNEP Finance Initiative in the Context of the SDG-Climate Facility. Available from: https://www.unepfi.org/regions/africa-middle-east/a-new-approach-to-unlocking-private-finance-for-climate-and-the-sdgs-in-egypt-morocco

UNFCCC (United Nation Framework Convention on Climate Change). (2022), Technical Assessment of Climate Finance in the Arab State: Annex to the Arab States Climate Finance Access and Mobilization Strategy. Available from: https://unfccc.int/sites/default/files/

resource/UNFCCC_NBF_TA_AS_final.pdf

UNFPA (United Nations Population Fund). (2011), Population Dynamics and Climate Change. Available from: https://www.uncclearn.org/wp-content/uploads/library/unfpa30.pdf

United Nations. (2020), Policy Brief: The Impact of COVID-19 on the Arab Region-An Opportunity to Build Back Better. Available from: https://unsdg.un.org/resources/policy-brief-impact-covid-19-arab-region-opportunity-build-back-better

Wang, X. (2020), How Data Scientists Can Train and Updates Models to Prepare for COVID-19 Recovery, KDnuggets. Available from: https://www.kdnuggets.com/2020/04/data-scientists-train-models-covid-19-recovery.html

Wang, Y., Zhi, Q. (2016,) The role of green finance in environmental protection: Two aspects of market mechanism and policies. Energy Procedia, 104, 311-316.

Watkiss, C. (2020), Coronavirus: The Immediate Effect on Climate Change. Climate Action, March ed. Available from: https://www.climateaction.org/news/coronavirus-the-immediate-effect-on-climate-change

Weber, O., Elalfy, A. (2019), The development of green finance by sector: The rise of green finance in Europe: Opportunities and challenges for issuers, investors and marketplaces. New York City: Springer International Publishing, p53-78.

Wen, C., Akram, R., Irfan, M., Iqbal, W., Dagar, V., Acevedo-Duqued, A., Saydaliev, H. (2022), The asymmetric nexus between air pollution and COVID-19: Evidence from a non-linear panel autoregressive distributed lag model. Environmental Research, 209(6), 112848.

World Bank. (2020), Developing a National Green Taxonomy-a World Bank Guide. Washington D.C.: World Bank Group. Available from: https://documents1.worldbank.org/curated/en/953011593410423487/pdf/developinga-national-green-taxonomy-a-world-bank-guide.pdf

World Bank. (2021), Private Participation in Infrastructure Database. Washington D.C.: World Bank Group. Available from: https://ppi.worldbank.org/en/ppi

World Bank. (2022a), Egypt: The First Sovereign Green Bond in the Middle East and North Africa: Case Study. Washington D.C.: World Bank Group. Available from: https://thedocs.worldbank.org/en/doc/931e017a795e984d79cfcaccadac563f-0340012022/original/16341-wb-egypt-case-study-web.pdf

World Bank. (2022b), Egypt Profile. Washington, D.C.: World Bank. https://data.worldbank.org/country/EG

World Bank. (2022c), Sovereign Green, Social and Sustainability Bonds: Unlocking the Potential for Emerging Markets and Developing Economies. Washington D.C.: World Bank Group. Available from: https://thedocs.worldbank.org/en/doc/4de3839b85c57eb958dd207fad132f8e-0340012022/original/wb-gss-bonds-survey-report.pdf

World Bank. (2022d). Supporting Egypt's Inaugural Green Bond Issuance. Washington D.C.: World Bank Group. Available from: https://www.worldbank.org/en/news/feature/2022/03/02/supporting-egypt-s-inaugural-green-bond-issuance

Wyns, A. (2020), How Our Responses to Climate Change and the Coronavirus are Linked? World Economic Forum (WEF). Available from: https://www.weforum.org/agenda/2020/04/climate-change-coronavirus-linked

Xin, D., Ahmad, M., Khattak, S.I. (2022), Impact of innovation in climate change mitigation technologies related to chemical industry on carbon dioxide emissions in the United States. Journal of Cleaner Production, 379(1), 134746.

Yang, L., Ren, Y. (2020), Moral obligation, public leadership, and collective action for epidemic prevention and control: Evidence from the corona virus disease 2019 (COVID-19) emergency. International Journal of Environmental Research and Public Health, 17, 2731.

Yang, Z., Abbas, Q., Hanif, I., Alharthi, M., Taghizadeh-Hesary, F., Aziz, B. (2021), Short-and long-run influence of energy utilization and economic growth on carbon discharge in emerging SREB Economies. Renewable Energy, 165, 43-51.

Yu, H., Solvang, W.D. (2020), A fuzzy-stochastic multi-objective model for sustainable planning of a closed-loop supply chain considering mixed uncertainty and network flexibility. Journal of Cleaner Production, 266, 121702.

Zhang, D., Mohsin, M., Rasheed, A. K., Chang, Y., Taghizadeh-Hesary, F. (2021), Public spending and green economic growth in BRI region: Mediating role of green finance. Energy Policy, 153, 112256.

Zheng, G.W., Siddik, A.B., Masukujjaman, M., Fatema, N. (2021), Factors affecting the sustainability performance of financial institutions in Bangladesh: The role of green finance. Sustainability (Switzerland), 13(18), 10165.

Zhou, X., Tang, X., Zhang, R. (2020), Impact of green finance on economic development and environmental quality: A study based on provincial panel data from China. Environmental Science Pollution Research and Management, 27, 19915-19932.