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GREEN FINANCE, ENVIRONMENTAL POLICY STRINGENCY, ENVIRONMENTAL TECHNICAL INNOVATION, ECONOMIC GROWTH, INDUSTRIAL STRUCTURE AND ENVIRONMENTAL QUALITY NEXUS: EVIDENCE FROM THE OECD

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**NEAR EAST UNIVERSITY**

**INSTITUTE OF GRADUATE STUDIES**

**BANKING AND FINANCE**

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**MSc. THESIS**

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**M.Sc. THESIS**

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**NICOSIA**
**JUNE, 2023**

# APPROVAL

We certify that we have read the thesis submitted by **YUSUPHA DRAMMEH** titled **"green finance, environmental policy stringency, environmental technical innovation, economic growth, of industrial structure and environmental quality nexus: Evidence from 15 OECD economies"** and that in our combined opinion it is fully adequate, in scope and in quality, as a thesis for the degree Master of Social Sciences.

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## Declaration

I hereby declare that all information presented in this thesis, " green finance, environmental policy stringency, environmental technical innovation, economic growth, industrial structure and environmental quality nexus: Evidence from 15 OECD economies 2000-2018" was collected, analyzed, and presented in accordance with all academic rules and ethical guidelines of the Institute of Graduate School, Near East University. I further declare that, to the best of my abilities, any supplementary resources utilized in the preparation of this thesis are adequately cited, acknowledged, and referenced.

**Yusupha Drammeh**

**…/…/….**

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I sincerely thank Allah the exalted who has enabled me complete successfully and has also made me consider making a contribution to human welfare. Special thanks to my parents Mr. Karamba Drammeh and Mrs. Jankey Samateh and the entire family who have shown me assistance, endurance and motivation throughout every phase of the study and who also devoted a lot of time offering prayers for this work to be successfully completed.

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**Yusupha Drammeh**

## Abstract

**Green finance, environmental policy stringency, environmental technical innovation, economic growth, industrial structure and environmental quality nexus: Evidence fromthe OECD (2000-2018)**



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The goal of this research is to examine the effect on green finance, environmental technical innovation, environmental policy stringency, economic growth and industrial structure on the environmental quality of 15 OECD economies from 2000 to 2020. Numerous econometric techniques are utilized to scrutinize the effects of each parameter on the quality of environment. The study utilizes CIPS and CADF unit root tests to scrutinize the variables' stationarity. The slope heterogeneity of the data is checked utilizing the Pesaran and Yamagata (2008) and Bolmquist and Westerlund (2013) tests. For the cointegration test, Johansen and Westerlund (2008) cointegration tests are used to examine the long-term connection between the variables. To examine the short and long-term linkage between the variables, PARDL is employed and the findings depict that green finance and environmental technical innovation enhances environmental quality in OECD economies in the long-run. The short-run estimations however divulged that green finance positively and insignificantly impacts environmental quality while environmental technical innovation negatively and insignificantly impacts environmental quality. The empirical results also depict that environmental policy stringency, economic growth and industrial structure all significantly deteriorates OECD's environmental quality in the long-run. Similarly, the short-term also findings divulge that environmental policy stringency, economic growth and industrial structure all negatively influence the environment's quality. The Granger causality test findings show a unidirectional causation from GF to EPS and ETI to GDP growth. A non-directional causation from INDS to GDP growth,

ETI to EPS. The results also indicate a bidirectional causation from GF to LCF, EPS to LCF, ETI to LCF, GDP growth to LCF, INDS to LCF, ETI to INDS, GDP growth to EPS, GF to INDS, GF to GDP growth and GF to ETI.

Hence, the investigation recommends the OECD governments to upsurge funding in green finance and research and development activities in environmentally-connected innovations as well as stimulating the consumption of renewable energy in production.

***Keywords:*** Environmental quality, green finance, environmental technical innovation, OECD economies.

## Özet

**Yeşil finans, çevre politikası katılığı, çevresel teknik yenilik, ekonomik büyüme, endüstriyel yapı ve çevresel kalite bağlantısı: OECD'den kanıtlar (2000-2018)**

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**HAZİRAN 2023 Sayfa 87**

Bu araştırmanın amacı, 2000-2018 yılları arasında 15 OECD ekonomisinin çevre kalitesi üzerinde yeşil finans, çevresel teknik yenilik, çevre politikası sıkılığı, ekonomik büyüme ve endüstriyel yapı üzerindeki etkisini incelemektir. Her parametrenin çevre kalitesi üzerindeki etkilerini incelemek için çok sayıda ekonometrik teknik kullanılmaktadır. Çalışma, değişkenlerin durağanlığını incelemek için CIPS ve CADF birim kök testlerini kullanmaktadır. Verilerin eğim heterojenliği, Pesaran ve Yamagata (2008) ve Bolmquist ve Westerlund (2013) testleri kullanılarak kontrol edilmiştir. Eşbütünleşme testi için, değişkenler arasındaki uzun dönemli bağlantıyı incelemek için Johansen ve Westerlund (2008) eşbütünleşme testleri kullanılmıştır. Değişkenler arasındaki kısa ve uzun vadeli bağlantıyı incelemek için PARDL kullanılmıştır ve bulgular yeşil finans ve çevresel teknik inovasyonun OECD ekonomilerinde uzun vadede çevresel kaliteyi artırdığını göstermektedir. Bununla birlikte, kısa vadeli tahminler, yeşil finansın çevresel kaliteyi olumlu ve önemsiz bir şekilde etkilediğini, çevresel teknik inovasyonun ise çevresel kaliteyi olumsuz ve önemsiz bir şekilde etkilediğini ortaya koymuştur. Ampirik sonuçlar ayrıca, çevre politikası sıkılığının, ekonomik büyümenin ve endüstriyel yapının OECD'nin çevresel kalitesini uzun vadede önemli ölçüde bozduğunu göstermektedir. Benzer şekilde, kısa vadeli bulgular da çevre politikası sıkılığının, ekonomik büyümenin ve endüstriyel yapının hepsinin çevrenin kalitesini olumsuz yönde etkilediğini ortaya koymaktadır. Granger nedensellik testi bulguları, GF'den EPS'ye ve ETI'den GSYİH büyümesine tek yönlü bir nedensellik göstermektedir. INDS'den GSYİH büyümesine, ETI'den EPS'ye yönlü olmayan bir nedensellik. Sonuçlar ayrıca GF'den LCF'ye, EPS'den LCF'ye, ETI'den

LCF'ye, GSYİH büyümesinden LCF'ye, INDS'den LCF'ye, ETI'den INDS'ye, GSYİH büyümesinden EPS'ye, GF'den INDS'ye, GF'den GSYİH büyümesine ve GF'den ETI'ye çift yönlü bir nedensellik olduğunu göstermektedir.

Bu nedenle, soruşturma OECD hükümetlerine yeşil finans ve çevre bağlantılı yeniliklerdeki araştırma ve geliştirme faaliyetlerinde fonları artırmalarını ve üretimde yenilenebilir enerji tüketimini teşvik etmelerini önermektedir.

***Anahtar Kelimeler:*** Çevre kalitesi, yeşil finans, çevresel teknik yenilik, OECD ekonomileri**.**

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## ABBREVIATIONS

**CO2: Carbon dioxide**

**EG: Economic growth**

**GF: Green finance**

**LCF: Load capacity factor**

**GHG: Greenhouse gas**

**GDP: Gross domestic product**

**EPS: Environmental policy stringency**

**ETI: Environmental technical innovation**

**ARDL: Autoregressive distributed lag**

**CIPS: Cross-sectionally augmented panel unit root test**

**CADF: Covariate-Augmented Dickey Fuller**

**INDS: Industrial structure**

**RE: Renewable energy**

# CHAPTRE I

# Introduction

## 1.1 Background of the investigation

With the sudden upsurge in world temperatures, repeated incidence of natural tragedies and pollution, climate change has intensely captured the interest of researchers across the globe (Yan et, al. 2022). This climate change has subjected the quality of environment to a serious threat. The oceans and atmosphere have become warmed characterized by rising levels of seas, significant reduction in Artic sea ice and other issues related to climatic change. The harsh consequences of changing climates on humans and the environment are progressively apparent. Unprecedented wildfires, flood, economic instability, extreme weather, drought and heat waves cause billions of damages to humans and other living creatures on the earth. Habitats are experiencing sudden changes as a result of changing patterns of temperature and rainfall distribution brought by climate change. Developing nations like Africa are the most vulnerable to the effects of global warming (Filho et al. 2022). If unregulated the CO2 emissions will bring about a further 1 to 3 degrees census rise in world temperature by the current century's end (IPCC 2022). Consequently, environmental protection measures have been made throughout the past 20 years with the goal of accelerating the economy's shift to low-carbon economies in order to reduce harmful effects on the environment like ''global warming'', emissions of GHG, atmospheric contamination, and climate change (Agbugba and Iheonu 2018).

One of the measures in fostering environmental quality and preventing the inhabitants of the earth from the worst effects of a deteriorated environment is green finance. Green finance is a modern idea that delivers another path to financing for peoples, corporations, and governmental bodies keen to offer aid and partake in green initiatives or'' low carbon'' projects (Huang et al, 2019). Green funding is regarded as the point where environmental preservation and economic development converge. As said by the UN climate change conference (2021), GF and technologies are crucially significant in order to achieve a 40 percent decrease in GHG by 2030. As revealed by wang et, al. (2020), there exists two distinct manners in which green financing becomes a catalyst for changing how environmental improvement is carried out. It firstly promotes business owners to use safer ecological procedures and goods, afterwards it lowers emissions by

substituting energy-saving gadgets for high-energies gear. When farmers become conscious about environmentally friendly goods, the creation of GF additionally assists in reducing hardship. Farmers are being urged to cultivate eco-friendly, organically grown crops devoid of all substances that harm the ecosystem. China established a strong green finance strategy structure in 2015, becoming the first nation to do so globally (Lv et al., 2021). Chinese efforts to combat global warming and lessen the effects of GHG are now mostly focused on using green financing.

According to Bhattacharyya (2022), every area of an economy contributes to environmental damage in its own different manner. On that note, each nation has concentrated on ecological issues in order to attain long-run ecological enhancement. The term quality of the environmental refers to a group comprising environmental characteristics and attributes that have an effect on mankind as well as the rest of living creatures. Using green funding is indeed the sole means of ensuring long-run development. It allows for a comparison between environmental conditions as well as the needs and desires of various living organisms. The health of mankind and their comfort are enhanced because of the advancement in their ecosystem. It promotes mental wellbeing, makes it possible for people to recover from distress, and improves their ability to exercise, all of which lead to greater pleasure and improved mental wellness. The significance of governmental and commercial initiatives that enhance sustainability is tied to GF. Along with demonstrating the extra privileges and long-term rewards of these finance, it moreover illustrates the effects of emissions and global warming on mankind existence. **S**ubsequent generations must be protected by ecological preservation.

The standard of living is influenced by environmental factors. Pollution emissions in many sorts, that impacts every living thing, is becoming more and more expensive due to modern manufacturing. There exists a clear necessity to tidy up such toxic ecosystem while being fully conscious of GF because the ecosystem's decline is indeed a significant issue which is continuously becoming worse. These ecological implications possess a detrimental effect on keeping people healthy, which happens to be the main reason for people's living. It indeed is well known that mankind nowadays is struggling with an ecosystem unfriendly towards its aspirations to achieve an ideal life (Rafiq et, al. 2022**).**

Since the 2015 Paris treaty, green funding has grown in favor as a crucial tool for addressing concerns brought on by environmental harm and global warming. The goal of the Paris treaty is to keep global warming temperatures under 2 - $1.5^0$C by this century's end in order to safeguard both humans as well as the ecosystem from its harmful impacts (Hoegh-Guldberg et, al. 2018). Numerous worldwide institutions and economies have turned to sustainable growth and development strategies in response to the growing concerns about environmental protection and climate change reduction (Abbasi and coworkers 2021). However, a significant amount of funds must be raised in order to fulfill the Paris treaty's goal and the COP28 mission (Tollefson, 2018). As a result, after the crisis of 2008-2009, the OECD adopted a policy known as green growth. The ultimate goal of this policy is to augment GDP expansion and advancement together with making sure that the natural resources keep providing ecological services for the well- being of human beings. Projects like EFIM have been designed and established to enhance the flow of funds and investments in renewable energies. As part of the effort in insuring ecological sustainability, the OECD economies are undertaking heavy investments in clean infrastructures to minimize emissions (OECD 2023). At the national level, numerous OECD members have taken drastic measures in the promotion of environmental sustainability. New Zealand for instance, depends on natural resources for the progress of their agricultural and tourism sectors. In order to achieve carbon neutrality by year 2050, New Zealand, has implemented a number of laws, such as a commitment to supply the entirety of its electricity from ecologically friendly sources by year 2035 and to cut agricultural methane by 10percentage points by the end of this 20 year period and by half by year 2050. Belgium has the uppermost degree of waste recycling and has good networks to enhance disposal of wastes associated with chemicals and electronics. Germany is investing more than one-third of its recovery incentive funds in programs that will form the basis of European union's goal of making European Community the very first continent to achieve net zero carbon dioxide emissions, such as developing RE capacity and implementing transportation reform (MIT 2021). Denmark is also making immeasurable effort in becoming the world's green leader. The country has been discouraging the utilization of nonrenewable energy for several number of years and eventually became the top manufacturer of hydrocarbons among European nations, and

stopped giving new licenses for the extraction of gas and oil with the view to stopping businesses associated with fossil fuel usage in 2050 (Denmark climate change news ,2020).

According to the study of Pham (2019), the risk associated with the return of stocks of industries involving in pollution has risen since the 2015 Paris treaty. Because various industrialized and developing countries have implemented measures to assist minimize carbon dioxide emissions and accelerate the channeling of funding to clean and sustainable initiatives (Tudo et al. 2021). Numerous economies, comprising UK, Japanese, Mexican and Canadian economies, released government policy reports to notify the public regarding the damaging influences of CO2 emissions upon the ecosystem and the fears that climatic alteration brings. From the global spectrum, economies have approved the Paris Climate change minimization truce which happens to be a global truce with laws (Blau,2017). The finance industry has developed innovative tactics and techniques for guaranteeing that there is enough funding to support initiatives with ecological and community benefits in addition to progressively diverting resources from initiatives and enterprises with substantial adverse effects on both humans as well as their ecosystem, particularly the ones which will exacerbate global warming. This is done in order to attain a sustainable advancement.

Moreover, the demand for diverting from the use of fossil fuels and a switch toward channeling funds toward environmentally friendly schemes and initiatives that sustainably safeguard the earth have arisen in response to the necessity to lessen the impairment to the ecosystem resulting from CO2 emissions (Bergman, 2018).The global economy has grown at a never-before-seen rate, yet this has primarily been based on highly unsustainable boom that was followed by a sharp rise in the emission of pollution. consequently, the planet is facing difficult ecological threats that endanger the existence of mankind, such as degradation of the ecosystem and global warming brought on by a rapidly expanding population, the expansion of industries and urbans as well as a sharp increase in the demands for energy. These ecological issues and dangers actually impact ecological integrity and, most importantly, they endanger the conditions of the inhabitants of the earth. Thus, it's indeed essential to increase resources as well as energy efficiencies and a shift to balanced system which consumes fewer of both

for humanity to keep growing sustainably. By doing this, we could remove the ties that bind resource use to GDP expansion. Besides that, sustainability that guarantees both GDP expansion and ecological sustainability is possible. A sustainable ecosystem is vital to achieving sustainable growth.

Ecological technologies are becoming more important as the need for ecological sustainability grows. The far more effective strategy for addressing ecological issues and risks currently has been ecological innovations. Ecological innovation is essential because it has the potential to significantly influence a win win linkages" between GDP growth and ecological betterment and helps in sustainable advancement (OECD 2010). Within that regard, the significance of ecological technical innovations is rising both in terms of tackling the ecological issues facing the current population and guaranteeing the ecological sustainability for coming generations. Any innovation that is ecologically oriented and works to reduce harmful ecological externalities is referred to as an ecological innovation. Innovations involving administration, production, and other areas of the ecosystem's health are all considered forms of ecological innovation. Ecological innovation had gained a profound degree of focus with in huge body of ecological literature, which has analyzed its components while recognizing its true importance, especially Porter theory, that asserts a connection between ecological regulation and innovation claims that stringent, well-structured ecological regulations can spur effectiveness and ecological innovations that aid in ecological enhancement without raising manufacturing expenditures. The theory has been used as a starting point for several ecological innovation investigations. Consequently, several scholars are particularly keen on ecological legislation as the input to ecological innovations and productivity enhancement as the output of ecological innovation. Yet, ecological improvement as the added result of ecological innovations has gotten comparatively little emphasis. This finding implies that prior investigations on ecological innovations might not have been sufficient to confirm the crucial significance of ecological innovations in enhancing the ecosystem. The ability of ecological innovation to result in complete decrease in emissions is also questioned by some scholars. For instance, according to Kemp & Pearson (2007), ecological innovations may not always guarantee a complete reduction in ecological consequences.

They contend that despite the fact that more ecologically damaging innovations are supplanted by less dangerous ones, when the fresh ones are utilized more commonly in comparison to old ones, it might not lead to reduction in ecological depletion since all technical innovations , to certain degree, end up causing ecological deterioration when producing or consuming the goods.

According to Shaker et, al (2018), ecological innovation refers to practices that harm the ecosystem as little as possible. These initiatives comprise lowering waste, producing energy, utilizing nontoxic materials, increasing productivity, and more. After key events throughout the globe, awareness for ecological conservation emerged. For example, the massive industrial tragedy during the period 1984 in the Indian economy, deterioration of Ozone layer and so on. As part of the environmentalist movement, numerous countries, businesses, and institutions have passed legislations requiring green governance. Environmental sustainability as well as green governance are important. Making a company's activities more environmentally friendly can have a significant impact on its business. Their sustainable businesses may gain competitive edge as a result. Environmental innovation is used by businesses and institutions to maintain an ideal environment. Using services, goods, and technologies that don't harm the ecosystem's assets could help with this goal. For example, producers as well as software applications prevent damaging technological waste from causing environmental harms (Mustafa 2019).

Morelli (2011) pointed out that quality of an environment is an economic commodity having two different connotations. Firstly, it serves as a common good that buyers in the market are willing to make payments for. It indeed is reasonable to suppose that residents of affluent countries get exposure to technical developments which makes upgrading the air around them significantly less costly because GDP growth and technical improvement coexist. consequently, people in wealthy countries consume proportionally greater quality of the air relative to people in less wealthy economies. The other interpretation is associated with the notion that people will make greater expenditures on their ecosystem as a result of increased incomes, whereas the prices stay unchanged. In the OECD nations, encouraging technical innovation becomes a commonly acknowledged strategy for addressing ecological threats like Carbon dioxide emissions which results to serious

reduction in environmental quality. The OECD economies have shown great enthusiasm in promoting the quality of their environment by investing heavily in ecologically friendly technologies. As the sheer amount of patent revealed, OECD nations have seen an unmatched advancement in technical innovations. In particular, the amount of patent for the economies of OECD during 1996 was roughly 887009. And during the period 2015, it experienced 1361098 expansion. Between these two periods the quantity of patents for ecologically friendly innovations experienced a 54.45% growth (OECD, 2020).

Ecologically friendly technical Innovation is predicted to perform a key part for the world to be carbon neutral as the harsh consequences of climatic alterations are progressively apparent. Recent developments have offered the government sector as well as firms with a diversity of technical approaches, from low or noncarbon mechanisms to minimize CO2 emissions (Sovacool, 2021). Cheng et, al. (2021) emphasized that the quality of the environment can improve via conservation of energy. Changing our collective behavior and using new technologies will be necessary to reduce our carbon footprint, and this may only be feasible with the help of legislative actions (Männer et al., 2012). As indicated by pledges made at the UN Climate chance Meeting, comprising 25 percent of the upcoming EU budget dedicated to climate initiatives, and twelve( 12 ) billion ton yearly reduction of emissions by China, policymakers are now becoming keenly aware of the need for innovations that address climate change (UN, 2019). In order to maintain an ideal and clean ecosystem, green innovation implementations should be heavily focused on GDP growth. Fresh air, quality water sources, as well as environmentally friendly waste disposal are just a few of the elements that are required to keep the ecosystem suitable for our living. For there to exist a good planet, particularly for coming years, it really is essential that we preserve ecological integrity. Green lifestyles, green economies, as well as clean technologies are the main three issues discussed upon the platform of UN in terms of climate change**.**

According to Li and Wang (2017), technology can reduce emissions in two distinct ways: by reducing the amount of emissions produced during manufacturing and by implementing "end of pipe" restrictions. In the latter, carbon dioxide (CO2) is captured and stored. These technologies are still in their infancy, thus there are relatively few opportunities for adoption and practicality. In fact, carbon capture and storage

technologies have little impact on climate change, according to Sgouridis et al. (2019) in the investigation they recently undertook. On the other hand, employing renewable energy sources can result in bigger decreases. Therefore, the creation of technologies that will lead to low carbon is essential to lowering CO2 emissions (Nordhaus, 2007). way Hung and Saleem (2020) mentioned the correlation between environmental depletion and renewable energy as positive and also significant. As a result of the over dependence on nonrenewable energies for the projects of infrastructure the ecosystem is seriously harmed (Montalbano Nenci, et al.2019). A similar statement was emphasized by shen et, al. (2020) that environmental depletion in advanced and developing nations can emanate from the excessive usage of nonrenewable sources of energy. According to Ansari et, al. (2021), lessening in additional energy usage with respect to the phases of production is another way of improving the environment.

Furthermore, environmental policies and laws perform a paramount part in attaining ecological sustainability. The persistence of flooding, deforestation and soil erosion is a clear manifestation of the weakness of water and land management policies to restore the natural ecosystems. And the absence of coordination between economic policies and that of the environment profoundly renders the environment to degradation. Ecological regulations support wellbeing of mankind and long-run sustainable advancement. They work to attain ecological goals which the free forces of the market are unable to fulfill (y wolde Rufael 2020). In the alteration of the conduct of the producers and the consumers, these regulations frequently raise the price of ecological remediation and emissions. Ecological regulations' strictness has indeed been theorized as having an impact upon economic events, including, for example, efficiency and technical innovations. Yet, genuine empirical findings regarding impacts of strict regulations are scanty and tended to concentrate on certain regulations in particular situations (Kozluk et, al. 2014). This creates room for views that may sometimes suit the interests of the businesses and industries addressed by regulations, at the expense of issues that may affect the entire economy, including both possible financial and ecological issues.

Regulations have emerged as the pivot of any governments strategy to combat the devasting effects of climate change (Pinto et al ,2018). Many countries have embraced

policy instruments such as environmental levies on energies and transportation and other initiatives in fostering the development and use of renewable energies (Alsagr et, al. 2021). For example, He e t, al. (2019) emphasized the contribution of environmental levies in reducing carbon dioxide emission in Chinese economy and OEDCS. Products with high energy costs and carbon emissions may be subject to taxes; doing so will compel businesses and consumers to buy and use more environmentally friendly goods (Mardones et, al. 2018).

As mentioned above, environmental legislations are widely acknowledged to have a growing contribution to safeguarding the ecosystem. Theoretically, ecological laws could affect the quality of ecosystem by creating the impression that rigorous ecological regulations render it much more expensive for manufacturers and users of products to modify their actions in ways that negatively impact the ecosystem. Firstly, authorities impose stricter controls on businesses, goods, and activities that produce a lot of pollution, such as more taxes and reduce emissions limitation goals. Owing to these legislative limits, economic actors are forced to limit their operations, decrease reliance on dirty energies like coal, and increase reliance on renewable sources of energy like wind. Secondly, authorities may create means to foster the advancement and usage of eco-friendly technology, that effectively slow down ecological harm (Paramali et, al. 2022). The rules for luring and allocating investments, particularly FDI, are favorable to the quality of ecosystem. The authorities may screen and obstruct initiatives that have an adverse environmental impact via strengthening the environmental criteria for coming investment initiatives.

Ecological laws perform a key part in reducing the effects of EG on ecological integrity overall. These ecological laws, though, could have a two-edged effect in which tougher regulations hasten ecological damage. According to some academics, ecological measures sometimes have unexpected consequences that worsen ecological contamination. This is described by the concept of green paradox. Firstly, Improper identification and implementation of ecological regulations, like trading program for emissions, may result to high pollution rather than a decrease. Secondly, manufacturers will enlarge their manufacturing and use of energy, chiefly those got from nonrenewable energy, when such law exclusively tackles the aspect of demand of

ecological consequences. Consequently, energy providers that are conscious of the slow energy revolution would utilize resources more, leading to increased pollutions as well as natural resource exhaustion. The impacts of ecological legislation in fostering technical innovations also has a contradictory consequence. In contrast to excessively strict law, which could dramatically raise the expense of adherence, moderate degree of ecological laws promotes the study and creation of green innovations. The amount that a company spends on technical innovation and also the implementation of environmentally conscious innovations is decreased by this huge financial burden. Fourthly, the racing towards a bottom concept suggests that emerging economies might slacken existing ecological laws in order to attract foreign investments. In an economy, the authority might vie with the surrounding nations by reducing ecological oversight to draw assets and accomplish rapid GDP expansion wherein the ecological consequence is ignored. The nations and regions hosting suffer from terrible ecological quality as a result of these low policies and implementation (Lia, 2019).

Ecological factors also steer the industries toward becoming more eco sound. To meet the needs of increasing number of people, increasing living conditions, and dwindling natural assets, there has been an industrialization all across the world. Using chemicals as well as nonrenewable energy by industries results in ecological pollution. Because that industries have a considerable detrimental impact upon the ecosystem, there needs to be a greater importance put on ecological integrity. Environmental damage is inflicted by industrial pollutants in addition to impairment to public health. Such factors lead to many effects, including modifications associated the systems of weather, ozone layer destruction brought on by GHGE, emissions of carbon dioxide, as well as other chemical emissions. , Additionally, the excessive number of automobiles as well as trucks that are in use also adds to ecological pollution, that requires the critical consideration of appropriate agencies and aiding financially to replace outdated transport modes (Afzal et, al. 2021).

Additionally, as the desire for economic expansion continuous to increase exponentially, environmental quality is also continuously subjected to a serious threat. The prior literatures, employed the EKC by Grossman (1991) to comprehend the nexus between EG and the environment. This theory is centered around the belief that

ecological degradation occurs due to economic expansion when nations are just starting out and wanting to produce more goods without taking into account ecological costs. The magnitude therefore rules the economies at this point, and large production only is possible by using a tremendous energy quantity as well as other productive resources. This increases the waste generated and the contamination of the ecosystem. Yet, the transformation process that influences ecological integrity typically characterizes the very next phase. The compositional impact is thought to dominate at this point when countries evolve existing economic structures from the primary (agricultural) to the secondary (industrial), and finally, to tertiary sector, with the least amount of environmental harm. The method impact, that greatly contributes to ecological integrity by advancing technologies and fostering knowledge as well as creativity, also is prevalent as income rises. Ecological depletion and EG therefore typically have an inverted U-shaped connection. Several variables, including innovations, technologies, ecological preferences, ecological restrictions, etc., will determine when this relationship turns. The WB (2019) said that growth in GDP cohabits with environmental depletion which China and the rest of BRI nations know of. According to UNDP (2022), supplying the globe with added clean, efficient energy would inevitably aid in maintaining the ecosystem, that will ultimately maintain future GDP growth

Thus, this investigation relates to the impact of green finance, economic growth, environmental technical innovation, environmental policy stringency and industrial structure on environmental quality in 15 0ECD economies (France, Finland, New Zealand, Netherland, Belgium, Sweden, Canada, Austria, Denmark, Norway, Germany, Switzerland, Spain, Ireland and United Kingdom). These economies have shown a great enthusiasm in enhancing environmental sustainability by implementing policies geared towards environmental protection and have also devoted a lot of financial resources to the journey. Figure 1 depicts the linkage between green finance, environmental technical innovation, environmental policy stringency, GDP growth and industrial structure and load capacity factor from the period 2000 to 2018.

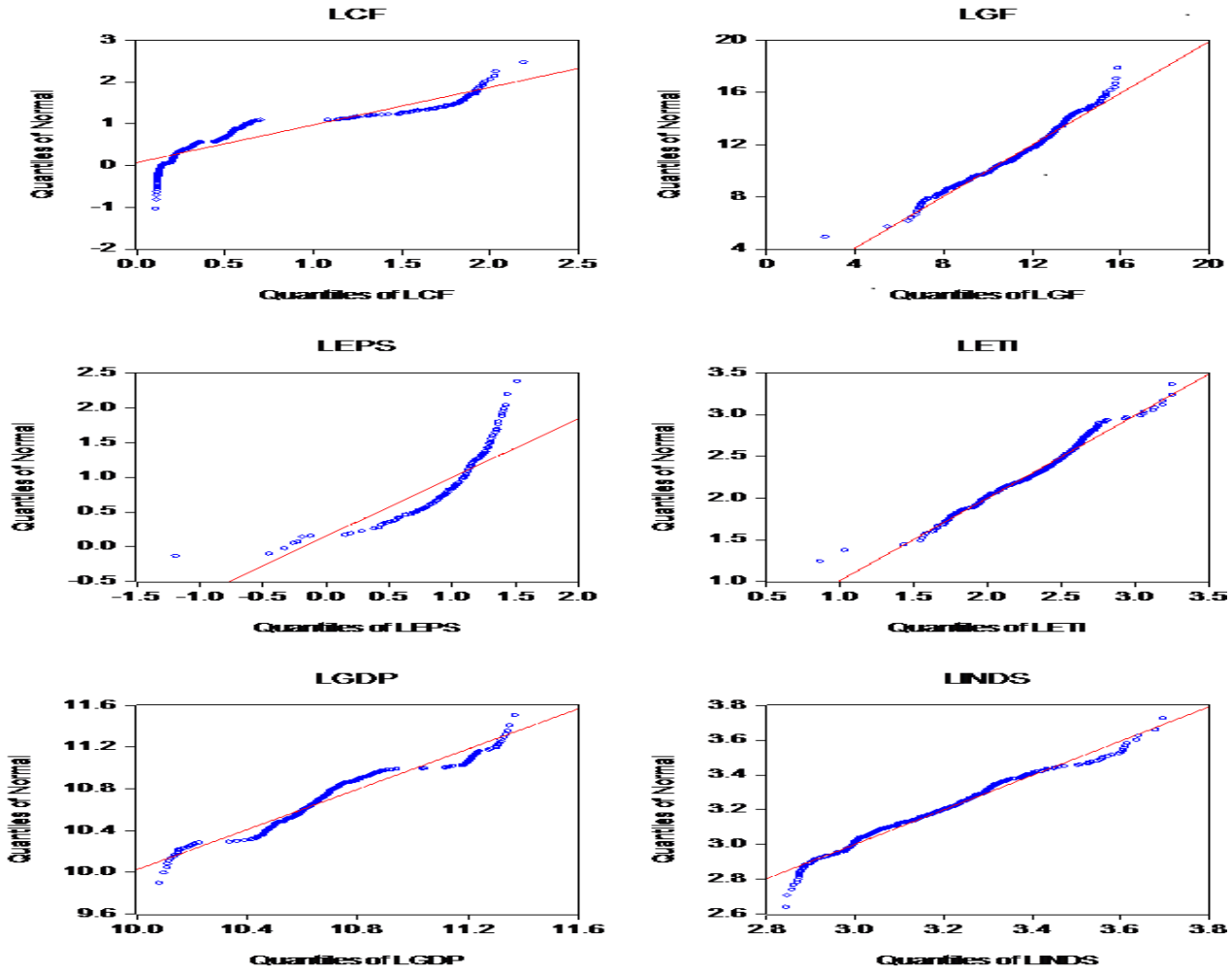



**Figure 1 Graphical representation of variables**

### 1.2 Problem statement

The grave danger of our time is climate change as a result of its immeasurable impacts on environmental depletion. Mankind activities are responsible for its occurrence. The rising water levels, severe storms, food shortages, economic hardships, natural catastrophes are increasing exponentially. Domestic and external effort as well as policy modifications are needed to combat climate change. Yet, people, families, and societies all play important roles. Today, however even those that never accepted climate change have now recognized that mankind activities associated with the emission of CO2 and other GHG play a magnificent role in environment depletion. For the last 20 years, the danger posed by accelerating altering climates has received the mainstream of global

attention. Studies related to the influences of changing climates on economy of the world had been conducted extensively since mid-1990s. To lessen the worst impacts of changes in climate, several international organizations, such as UN, have indeed been seeking to construct legally enforceable agreements between governments.

The OECD economies have been making tremendous effort to combat the dangers that human activities have subjected the environmental. Projects such as CEFIM have been implemented with the view to fostering the production and utilization of renewable sources of energy which are ecologically conscious and discouraging the utilization of nonrenewable sources of energy which are ecologically unfriendly. Promoting ecologically-oriented technical innovations becomes the widely acknowledged weapon in the battle against practices that leave the ecosystem depleted such as the carbon dioxide emissions. However, several others are being blamed for not taking drastic actions so as to stay away from fossil fuel usage. It is crucial for governments and other policymakers to come together on how to rebuild back. The prospect of greener work and innovations motivates additional performance and enthusiasm since it will help us remain competitive in coming years. The GFI measures how committed and how far-reaching each nation is in its efforts to become a global leader in sustainability.

This investigation intends to divulge the effects of green finance, economic growth, environmental technical innovation, environmental policy stringency and industrial structure on environmental quality in 15 OECD economies.

### 1.3 Motive of the investigation

The persistence of flood, erosion, food insecurity, rising water levels of seas, deforestation, changing patterns of rainfall distribution and destruction of habitats are all as a result of mankind activities all of which is negatively correlated with environmental quality. The excessive usage of fossil fuel as a result of industrial expansion cause a serious reduction to the environmental quality.

Green finance has many positive impacts on environmental sustainability according to previous research investigations. For instance, according to Böhringer et al. (2015), green financing promotes investing in technological developments and ideas, such as RE. The use of RE has led to a decline in C02 and other GHG emissions. Increased flow

of money from credit companies to businesses engaged in environmental initiatives and endeavors are the aims of "green financing," which aims to help society reach its sustainability.

The objective of this investigation is to divulge the effects of green finance, economic growth, environmental technical innovation, environmental policy stringency and industrial structure on the environmental quality in 15 OECD nations namely France, Finland, New Zealand, Netherland, Belgium, Sweden, Canada, Austria, Denmark, Norway, Germany, Switzerland, Spain, Ireland and United Kingdom. These economies are profoundly working hard toward attaining green economies via investing in eco-friendly innovations and implementing rules.

### 1.4 Research questions

1. what type of impact does green finance have on environmental quality.
2. At what degree does economic growth affect environmental quality.
3. How does environmental technical innovation affect environmental quality
4. What impact does industrial structure have on load capacity factor.
5. To what extent does environmental policy stringency influence the quality of environment.

### 1.5 Hypothesis

This study utilizes two hypotheses namely HO, which means null hypothesis indicating that increasing green financing, economic expansion, changing industrial structures, increasing utilization of environmental technical innovations and implementation of environmental policy stringency have no significant effect on the quality of environment in 15 OECD economies. The second hypothesis is H1, which means alternative hypothesis which is opposite to the null hypothesis.

HO. a, Green finance has no significant effect on environmental quality.

HO. b, Economic growth has no significant effect on environmental quality.

HO. c, Environmental technical innovation does not significantly impact environmental quality.

HO. d, Environmental policy stringency does not significantly impact environmental quality

HO. e, Industrial structure induces no significant impact on the quality of environment.

H1. a, Green finance significantly influences environmental quality.

H1. b, Economic growth significantly influences the LCF

H1. c, Environmental technical innovation significantly impacts the quality of environment.

H1. d, Environmental policy stringency significantly influences environmental quality

H1. e, Industrial structure has a significant influence on LCF

**1.6 Contributions of the investigation.**

All of the previous investigations utilized CO2 and ecological footprint as proxies for environmental quality and each of these proxies has its own shortcomings. For example, ecological footprint which has been widely used by the previous empirical investigations only looks at the demand aspect of the ecological environment. Therefore, to precisely gauge the quality environment, a proxy that puts the whole environment into consideration needs to be used. Henceforth, this investigation chooses to use the LCF to correctly gauge the environmental quality of 15 OECD economies. This is because LCF, unlike carbon dioxide emissions and ecological footprint puts both the demand as well as the supply aspects of the environment into consideration. This investigation reveals the impact of green finance, economic growth, environmental technical innovation, environmental policy stringency and industrial structure on environmental quality using LCF as a measure of environmental quality. This is an immense contribution that the investigation makes which will be of profound benefit to future investigators.

**1.7 Scope of the investigation.**

This investigation is connected to the green finance, environmental policy stringency, environmental technical innovation, economic growth, industrial structure and environmental quality nexus in 15 OECD nations. The research investigation would be done between February 2023 and June 2023 utilizing the econometric techniques.

## 1.8 Definition of variables

Environmental quality- A group of environmental qualities have impacts on people and the rest of living things. These qualities might be broad or specific. It gauges how well an ecosystem meets the needs of man and other living organisms living in the environment. The quality of environment comprises factors like noise, quality of water, air and many other factors that may affect mankind and other living creatures in the environment.

Green finance refers to monetary investment made in programs for ecological sustainability, environmentally friendly goods, and laws that support the growth of an increasingly sustainable system. t. Additionally, it alludes to a broader spectrum of "additional ecological aims, such as reducing industrial emissions, water cleanliness, or the biodiversity preservation.

Economic growth – refers to the rise in the production ability of a nation with regard to her products on a comparative basis between two time periods after accounting for inflation. In other words, an economy's economy is expanding if the worth of her products upsurges, producing large amount of revenue for corporations. Henceforth, the prices of stock surge. This offers corporations with cash to enlarge and recruit additional labors. Incomes upsurges as a result of the creation of many new job opportunities. With enough money in their possession, customers might afford more goods as well as services, which transforms into quicker growth. Every nation desires positive GDP expansion resulting from of this. Traditionally, real GDP is utilized for gauging economic expansion.

Environmental technical innovations- refer to institutional initiatives and modifications with an emphasis on the ecosystem, with varying degrees of originality that have an impact on goods and services, processes of production and advertising of businesses. The fundamental goal is to lessen the firm's ecological impacts, which can be achieved by simple incremental changes that enhance what is already there or drastic one that push something wholly novel. Also, there exists a positive link between ecological innovation and how actively corporations manage their environmental impact. Growing environmental innovation frequently encounters numerous obstacles. In other terms, environmental innovation is the utilization of ecological sciences for the creation

of new technology with the goal of preserving, observing, or minimizing the damage that people regularly inflict upon the ecosystem by utilizing valuable resource. The cornerstone of green science is sustainable growth, a set of widely used methods that promote economic growth by preventing the future pollution and degradation of the ecosystem. The ultimate objective of environmental innovations to safeguard the environment from the harmful activities of human beings such as using fossil fuels and stimulate them to use RE which is eco-friendly.

Environmental policy stringency- refers to the organization's or government's entire environmental goals and guiding principles, which may include adhering to all applicable environmental legislative compliance as well as a dedication to continually fostering the performance of the ecosystem. It further serves as the foundation for establishing and evaluating environmental goals. Environmental policy rigors are measured by how much environmentally destructive behavior is penalized explicitly or implicitly. This policy may include management of waste, water pollution, air pollution, management of the naturally endowed resources and wildlife conservation. This approach could be intentionally implemented to affect human behavior and so avoid negative consequences upon the natural world and its resources, and also to ensure that environmental alterations have no intolerable repercussions on people and other living organisms.

Industrial structure- it represents the key composition of the nation’s socioeconomic production grouped as extractive, secondary and tertiary industry.

### 1.9 Limitations of the investigation

Firstly, accessibility to data is one of the main problems associated with this investigation as financial expenditures are made in other to get some of the research materials from the internet. Secondly, due to the difficulties confronted in running the Stata, the investigation is unable to use the CS-PARDL and normal PARDL is employed instead which conforms with the previous literatures such as Muhammad Awaise Balochi et, al. (2020), Evelyn Agba Tackie (2022). The investigation hence recommends the future investigators to use CS-PARDL in their analyses to produce superior outcomes.

This investigation is organized as follows: chapter one, which gives an introduction to the topic at hand, research problem statement, reason of the investigation, questions pertaining to research, hypothesis, contributions of the investigation, scope of the investigation, definition of variables as well as the limitations of the investigation. This chapter is followed by chapter two which focuses on the literature review on the study's variables. The chapter comprises both empirical and theorical literatures as well as the research gap between this investigation and the studies that had been previously done. Chapter three discusses the nexus among green finance, economic growth, environmental technical innovation, environmental policy stringency, industrial structure and environmental quality on the basis of the evidences from the data. The specification of the model, econometrics methods, sampling design are all done here. Chapter four focuses on results and the discussions while chapter five deals with conclusion recommendations.

# CHAPTER II

## Literature review

This chapter talks about the related preceding research investigations undertaken by scholars across the globe both empirically and theoretically

### 2.1 Empirical literature

#### 2.1.1 Green finance and environmental quality.

The UN Global agender for sustainability drew attention to the rising concerns about pollution of the ecosystem and the depletion of natural environmental resources, which opened the door for the introduction of contemporary ideas like sustained development. Historically, the financial industry did not care about the environment, but it is now starting to take environmental concerns into account and introducing new financial instruments that are expressly geared toward environmental conservation, including green loans. About its meaning, there is still disagreement among the academic community. In broad terms, green finance refers to a type of modern finance that provides capital, operating funding, as well as many financial facilities for initiatives that promote environmental protection (Tolliver et al. 2021).

As reported by recent research, GF can foster the quality of environment via aiding ecological rules and minimalizing CO2 emissions (Brandi et al., 2020). It can cut down the use of fossil fuel by 26percent, causing a 12.4 percent drop in carbon dioxide emissions (IEA, 2017). According to Lin and Jia (2017), the most efficient way to minimize environmental depletion is via environmental finance. Guo et, al. (2022) examined the influence of GF on agricultural carbon emissions. They came with a discovery that GF possessed a negative consequence on agricultural carbon emissions. Furthermore, when Gholipour et, al. (2022) looked into the influence of green properties finance on CO2 emissions, based on the results they also concluded that the two are negatively corelated. Similarly, Saeed and Moe (2022) looked into the effects of GF on GHE in the leading economies in supporting green finance. The findings exhibited a negative correlation between them. Wu (2021) discovered that firms involved in ecological protection-related industries are more interested due to the swift advancement of green financing in

formulation of policies and implementation. Muganyi et al. (2021), concentrating on China, examine whether the country's GF connected measures have profoundly minimized industrial gas emissions by analyzing data from 290 cities between the period 2011 to 2018. A DID methodology was used to discover that policies related to green finance initiatives had a substantial positive impact on the environment, as evidenced by a 38 percent drop in Sulphur dioxide emissions, a 28 percent drop in industrial emissions, and a 20 percent drop in total Sulphur dioxide production. Additionally, they discover that the rise of fintech aids China move to a green financial system, which reduces emissions. According to Narsreen et, al. (2017), the finance sector itself helps to raise environmental standards as it gives financial assistance to businesses and initiatives that encourage environmental protection. Financial progress could encourage the modernization of systems of industries and this drama crucial part in lowering the usage of energy and emissions of carbon.

In minimizing ecological pollution, economies must consider climate-friendly initiates as reported by UNFCCC. GF appears pivotal in fostering this activity. Resultantly, for economies to transfer to green economies from only booming economies, managements must deliver GF (Shen et al., 2020). Li (2022) believed that green finance was a crucial component of attaining net zero carbon dioxide emissions and integrating environmental management with economic growth.

According to Gianfrate, Peri (2019), among the most important strategies for mobilizing financial funds to meet the Paris Treaty's goals for reducing carbon emissions is through use of green bond.

Zhao et al. (2020) utilized the EKC hypothesis to look into the connection between green financing and economic advancement as well as ecological sustainability. They discovered positive correlation between green financing and environmental advancement, but this depends on the difference in economic advancement levels. Shen et, al. (2021) assess the short run and long run impacts of green investments on carbon dioxide emissions utilizing the ARDL model utilizing a sample comprising 30 provinces in Chinese economy from the period 1995 - 2017. According to this methodology, the researchers discover negative correlation between green investments and CO2 emission in short- run as well as long-run, though the long-term

impact is clearly less significant in comparison to short-term impact. This could represent a sign of declining gains of green financing over period, however they don't study further, that might be very useful. Li and Gan (2021) look into the impact of green financing on ecosystem, developing an in-depth index that combines both favorable and adverse indicators, like discharges of wastewater, encroachment of desert and industrial wastes investments. The outcomes show that, green funding doesn't only significantly improve the ecological condition of places question but additionally the neighboring territories. They indicate that green financing has significant beneficial spillover effects, although free - riding issues could arise if such positive externality is still not sufficiently internalized.

There are however a handful of literatures that concluded that environment quality is hampered by financial development. For instance, Xing et, al. (2017) divulged that by increasing the manufacturing size of businesses, financial developments damages ecological integrity. A similar conclusion was given by Shahbaz (2017) when he said that it only causes an upsurge in energy use and resources. He et al. (2019) also found that growth of green financing has a detrimental effect on the issuing of loans of banks, that, to some degree, limits the effectiveness of renewable energy investments and, henceforth, possesses a detrimental consequence on ecological sustainability.

According to Cui et al. (2020), still there remain significant obstacles facing GF, including an absence of GF (green finance) program setting, a greater access bar for businesses, and a dearth of the upstream service organizations and the downstream service organizations. A fascinating GF strategy that makes use of loans depending on emission rights is studied by Chen et al. (2017). Within this approach, businesses engage in environmentally friendly technologies as well as pollution reduction, which releases their emissions rights. The emissions permits are then utilized as security when requesting loans. According to authors theoretical framework, the emissions permit-based loan approach works at encouraging expenditure on environmentally friendly technology while also being lucrative for the enterprise and banks, provided that the demands of market is at rational level. As a result, they demonstrate that GF is profitable.

There are few scholars who pointed out that green finance does not lead to a significant enhancement in the quality of ecosystem. For instance, 26 nations were evaluated for

linear link between GF and the quality of environment by Khan et al. (2021), who also found that green money does indeed seem to be environmentally favorable as expected, particularly from the perspective of the Asian nations. Similar to this is the investigation of Digan et. al. (2016) when the they concluded that green finance does not have any effect on the ecological integrity and emissions.

### 2.1.2 Economic growth and environmental quality

There are several variables that affect each nation's level of GDP expansion at any given period. Different countries methods have included development on the basis of each nation's unique qualities and the prospective environmental assets which are accessible in order to foster a rapid increase in GDP. Numerous factors, including environmental conditions (pollution), excessive use of ecological assets, habitat deterioration and extinction, and global warming, can all have an adverse effect upon the ecosystem as a result of this GDP growth. The aforementioned are some the main problems that several nations have indeed been dealing with; especially, the deterioration of ecosystem is thought to pose a severe problem for humans and other living creatures living conditions both now and in future

As nations have intense desire for economic growth, environmental depletion has become a profound threat to ecological economists. These economists used the EKC theory to explore the link between environmental quality and economic growth. There are scholars that established the validity of EKC hypothesis and there are others that do not.

For instance, Balsa-Barreiro et al (2019) undertook an investigation on the manner increase in GDP influences CO2 emissions, Population in cities and worldwide between 1960 - 2016. Discussing the global changes in human dynamics is crucial in the context of population dynamics, GDP dynamics, and environmental damage. All of the aforementioned issues are closely related to globalization and assessed using the center of gravity. According to the statistics figures, the biggest emitters and economies worldwide are Japan, China, EU, and the US. The outcomes also show the decoupling impact, in which the GDP trace changes more quickly than the CO2 trace. The EKC has been utilized in several empirical assessments over the past 20 years to determine the

association between environmental quality and the level of income. The existence of EKC in European nations is supported by a number of empirical analyses (e.g., Auci and Trovato, 2018); their discoveries divulged that EKC existed in 25 European economies between 1997 -2005. Abbasi et al. (2021) in Thailand, used DADL technique to depict the relationship among energy consumption, RE and carbon dioxide emission. The results revealed that renewable energy diminished the emission of carbon dioxide whereas GDP expansion and fossil fuel usage both positively and significantly influence carbon dioxide emission in short-run and long-run. Dong et al. (2018) investigated the correlation among carbon dioxide emissions, derivates of petroleum, renewable energy, economic development and thermal power in Malaysia and the findings divulged that, in the short run and long run the influence of fossil fuel wastes can be eased with the usage of nuclear and RE sources of power. And thermal and environmentally friendly sources of energy have a very little impact on diminishing carbon dioxide emission in the country. Using the PSTR model, Esen, and Aydin (2019) tested EKC's validity comprising 26 EU nations from 1990 - 2013 but found no evidence to support it. Radmehr et al (2021) looked into the linkage among economic development, carbon dioxide emission ansd RE and this investigation comprised 21 countries of EU from the period 1995 -2014. The findings of the investigation revealed two directional links between carbon dioxide emission and economic development and RE and economic development. However, the investigation by Aşc and Acar (2018) looked at the connection between income and footprints for eight-seven countries between 2004 and 2010, and the findings refuted the validity of the EKC theory. Namahoro et al (2021) investigated energy consumption, financial advancement and carbon dioxide emission in more than fifty nations in Africa. They used data of these economies from the period 1980- 2018 and came to the conclusion that rendered EKC invalid and started that the usage of RE power led to the reduction of carbon dioxide emission whereas the emission of CO2 became high with energy intensity across nations and levels of income.

### 2.1.3 Environmental technical innovation and environmental quality.

Numerous studies suggested that technology advancement, particularly in the industrial process, might dramatically reduce CO2 emissions without impairing GDP

development. In the context of China, Lin and Zhu (2019) looked at the relationship between environmental depletion and renewable technology. According to their statistical findings, technical advancement from renewable energy sources is enhancing China's environmental quality and fostering the growth of a low carbon environment. The ecological footprint of 22 growing economies was examined by Ahmad et al. (2020), who came to the statistical conclusion that technological progress makes it possible to reduce ecological footprint. Technology innovation is a key component of attaining ecological sustainability in the N-11 nations, according to Wang et al ( 2020) 's analysis. In the same, Guo et al. (2021) looked into how technology innovation affected the environmental quality in China and came to the conclusion that technological innovation might help attain the Sustainable Development Goals. The findings of Samargandi (2017) examined the link between environmental contamination and technological change in Saudi Arabia but were unable to identify how important technological innovation is to reducing environmental depletion. Between 1990 and 2016, Dauda et, al. (2021) revealed an inverse bond between the emission of carbon dioxide and environmental innovation in few nations in Africa. With the utilization of 1992 and 2014's data, Töbelmann and Wendler (2020) looked at the way environmental innovation affects Emissions of carbon dioxide in 27 European union nations. They observe that the effect of innovations differs between nations, with underdeveloped nations frequently displaying a greater level of variability. Furthermore, they discover that only ecological innovation has an impact on the lowering of emissions carbon dioxide. Similar to this is the statement of Du et. al. (2019) that Green technologies get a minor influence on the minimization of CO2 emissions in countries with levels of income under the benchmark, but they have a massive effect in countries with levels of income higher than the benchmark.

### 2.1.4 Environmental policy stringency and environmental quality

This part of literature review examines the correlation between environmental policy stringency and environmental quality. Environmental legislations and policies are implemented with the view to providing solutions to the ecological glitches that the globe is undergoing. By doing so, producers as well as consumers are discouraged from engaging in activities that act as catalyst to environmental depletion and are encouraged

to undertake ecological friendly practices. These policies increase the cost of environmental unfriendly practices such as pollution emissions.

To reduce the worsening environmental quality, rigorous environmental laws and regulations are being encouraged; as a result, strict environmental policy is crucial for minimalizing the emission of carbon dioxide. By raising the cost of services that pollute the environment producers and customers will be discouraged from using those services and divert their attention towards using environmentally friendly items. Ecological rules would raise the price of contaminated (dirty) products and activities, according to Neves et al. (2020). Ecological rules and outcome were emphasized by Mulatu et al. (2018). They came to the conclusion that enacting environmental regulations and using eco-friendly technology could minimize the emission of carbon dioxide. ( Lagreid and povitkina 2018) claim that eco-friendly technology should take the place of environmentally "dirty" ones since strict environmental regulations and environmental fees posess a large positive influence on the pollution of the ecosystem . When Panayotou et al. (2000) looked at how organizations and rules affected ecological integrity, they found that stronger administration and policies had a significant impact on Pollution of the ecosystem. The quality of the ecosystem will therefore be impacted by development-focused organizations and laws. The paper by van Leeuwen and Mohnen (2017) examined empirical evaluations of the relationship between environmental quality and rule, although the conclusions are not definitive. Between 1990 and 2008, a decrease in CO2 emissions was observed in the US, according to Shapiro and Walker's (2018). The investigation by Wolde-Rufael et, al. (2021) examined the role of ecological strategies for a few growing nations from the period 1994 - 2015 and their efficacy in decreasing environmental degradation. De Angelis et al. (2019) looked at environmental regulation and its effect on the quality of the environmental for the nations of OECD in a similar vein. Due to strict environmental laws, they discovered a considerable decrease in emission of carbon dioxide. But according to Wang and Wei (2020), strict environmental regulations do not result in better increase in the quality of the environmental through lower emission of carbon dioxide.

### 2.1.5 Industrial structure and environmental quality.

Varying conclusions have been drawn with respect to the link between industrial structure and environmental quality. For example, Cia and Li (2009) examined the impact of pollution of the ecosystem and the economic advancement in Chinese economy since the period 1991 using income per capita and industrial system. The findings revealed that industrial system significantly affected ecological quality. They stated that the presence of greater number of industries in a nation's economy reduces ecological quality. When Wang and Dong (2010) examined the correlation between restructuring of industries and the quality of ecosystem in the area of gansu based on the view point of industrial structural change, the findings pointed out that industrial structural changes led to development of economy as well as immense pressure on the environment. Among the three (3) types of industrial systems, pressure on the environment increases rises when secondary industries are the dominants due to the fact that secondary industries are associated with excessive usage fossil fuels which is associated with high pollution emissions (Zhou, 2015). The investigation of Liu et al. (2021) divulged that industrial sector has a deteriorating effect on the environment. This assessment is composed of 30 provinces of China and the findings concluded that industries possess a positive influence on ecological decay in every quantile. According to Raza and Hasan (2022), it is connected to the industrial sector's technological advancement, which is unable to considerably slow down destruction of the environment because of issues related to the quality of energy. The same influence on African economies is also discovered by Nwani et al. (2022), with the intensity being greater in nations with more extractive sectors. This is related to the industry's capacity to enhance its production procedures and the reality that productivity is increased by the movement of production elements within the sector (Salman et al., 2022). According Wu et, al. (2018) industrial structure's adaptation influences modifications in reaction to alterations in various locations.

However, Huan and Li (2010) divulged that industrial system possesses more positive effects on the environment than the harms that it inflects upon it.

## 2.2 Research gap

It is observed that all the aforementioned literatures employed ecological footprint and emissions of carbon dioxide at measures of environmental quality. Due to this this potential gap, the study uses the LCF as a measure of environmental quality to examine the correlation between among green finance, environmental policy stringency, environmental technical innovation, economic growth, industrial structure and environmental quality.

## 2.2 Theorical literature

### 2.2.1 The environmental Kuznets (EKC) hypothesis

The EKC hypothesis shows the correlation between income per capita and numerous indicators of environmental depletion. At the beginning phases of GDP growth, there exists an upsurge in pollution emissions and a drop in the quality of the environment. But above certain level of income per capita, the trend reverses in order that GDP growth results to improvement in environmental quality. This correlation between income and the quality of ecosystem exhibits an inverted-U shaped function (Gossman 1991). This hypothesis becomes popular among scholars and dominantly utilized in examining the nexus between ecological quality and income per capita. For instance, according to Rongxing (2018), as the level of income rises pressure on environment rises but this pressure later decreases as the level of income decreases. The ecosystem is put under increasing stress due to increased usage of naturally endowed resources and C02 emissions. People neglect the negative effects of excessive pressure on the environment or they are so impoverished to make payments that can reduce environmental depletion. In the far along phases of industrial advancement, as affluence increases, people cherish the ecosystem more, governing agencies become much more efficient, and levels of pollution decrease. The efficient need for the quality of environment increases with affluence and finally outweighs any size impacts of increase in GDP on emissions of pollution, according to the EKC theory, which was mostly ascribed to behavioral issues (Stern, 2004). With increasing economic progress, economy would alter structurally along with rising environmental consciousness, stricter execution of ecological laws, and improved technology.

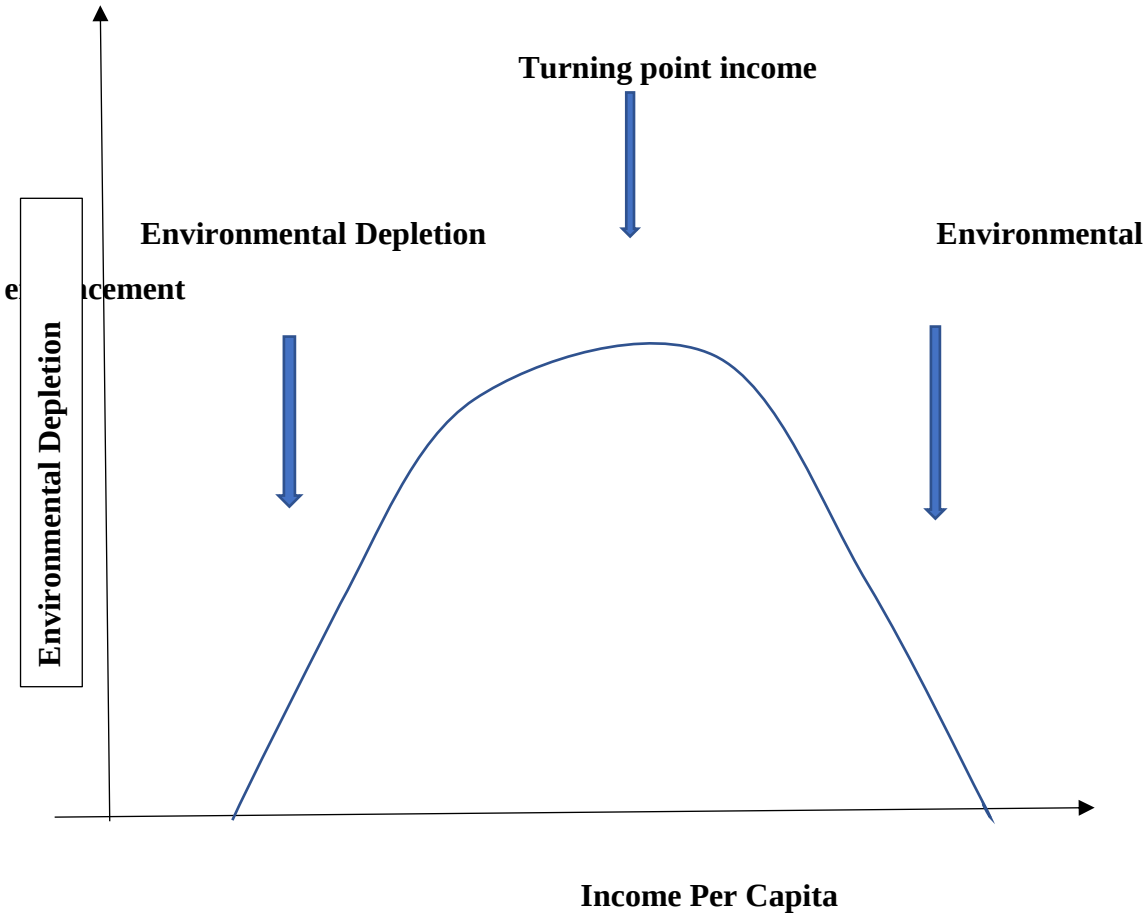



**Figure 2 Environmental Kuznets curve.**

The nexus between income per capita has a number of empirical evidences. For instance, Waheed et, al. (2019), reviewed the research on rise in GDP, energy use and emissions of carbon dioxide at the national and international stages. They precisely chose 24 single-country papers as well as 21 multi-nation articles which examined the connection between GDP growth expansion and CO2 emissions from 2007 – 2019. In line with the research's findings, the vast majority of research have established a one-way causal connection between GDP growth and carbon emissions. The GDP expansion and emissions of carbon dioxide are correlated in both directions, according to other surveys. The association between GDP growth and emissions of carbon dioxide has been documented in emerging economies, which is an intriguing result. In wealthy nations, no correlation exists between GDP growth and emissions of carbon

dioxide nevertheless. In their review of 175 papers from 1995 –2017 Mardani et, al. (2019) examined the link between expansion in GDP and carbon dioxide emissions. They advocate setting restrictions on expansion in GDP in order to reduce carbon dioxide emissions. They pointed out that due to the connection in both directions between expansion in GDP and carbon dioxide emissions, there existed possibility that expansion in GDP may be negatively impacted as well.

Utilizing data information, Uchiyama (2016) looked for the connection between GDP and ecological devastation for both advanced and developing nations. The findings show that $30,000 was the amount that caused this connection to change. Following this tipping point, nations' ecological devastation begins to decline due to a rise in per capita GDP.

According to Dasgupta et al. (2002), pollution emission is increasing quickly with in initial phases of industrialization since the chief goal revolves around boosting material output and because individuals have greater concerned with doing business to make money than getting fresh air and H2O. Fast economic expansion implies higher consumption of natural resources and emissions of pollution, that puts more strain upon the ecosystem's integrity. Individuals at these phases of GDP expansion are poor spend in upgrading ecological quality frequently overlook the effects that this GDP expansion subjects the ecosystem to.

Instinctively, the EKC relationship makes sense. Because increasing material product is given great importance during the initial industrialization phase and because individuals are more concerned with finding work and making money than with maintaining a quality environment, pollution increases quickly (Dasgupta et, al. 2002).

Only during the subsequent stages of GDP growth do levels of income significantly rise, which, when combined with improved institutional standards, a greater consciousness of ecological protection, and widespread adoption of new technologies and innovations, lead to reduction in devastation ecosystem (Sarkodie et, al. 2019).

Purcel (2020) examined 97 papers between 2010 and 2019 with the goal to examine the theory of ECK in emerging and transitional economies. Similar to this, numerous researches have shown that various parameters possess a long-run link. Certain emerging and transitional countries also support EKC's validity.

An EKC hypothesis illustrates the way a formally defined measure of quality of ecosystem changes as a result of changes in wealth of a nation or a stable human society. Thus, the environmental Kuznets curve established a clear influence of economic activities on the ecosystem.

### 2.2.2 Porter hypothesis

Protection of the environment and the competitiveness of the firms is considered incompatible as economists said. They argued that as firms look for their business goals, no attention is paid to the damages that are inflected upon the environment as a result of their activities. Thus, policies that are designed for them to be compelled to change the polices that have negative effects on the environment are fruitless most often. Every environmental rule that is externally enforced will be a restriction upon the business, or, to put it another way, a restriction on attainable region. This implies that businesses cannot benefit more from being bound by stricter environmental regulations because the answer to a restricted issue has no possibility of being better than the answer to unrestricted one. The idea of market inefficiency tells us that state action may be appropriate to address inefficiencies brought about by defects, the existence of products having free or general accessibility, or any imperfections associated with the market. Environmental regulations might well be vindicated because of societal as well as environmental concerns, notwithstanding the detrimental impact these might place upon the goals of individual companies.

This hypothesis (porter hypothesis) was developed by M. Porter in 1991. The hypothesis is normally talked about when one discusses the correlation between environmental laws and industrial competitiveness. According to the idea, severe ecological legislation spurs the development and adoption of greener technical innovations and ecological advancements, resulting in innovative effect, which increases the efficiency of manufacturing procedures and end goods. The expenditure reductions which could be realized are enough to offset the administrative expenses of innovation as well as the immediate adherence expenses associated with new rules. By exploiting innovation through studying benefits or licensing, a corporation can get an early-movers ahead of rival businesses in nations wherein ecological restrictions were implemented a

long time later. In REACH, PH's premise had been implemented. A potential finding is that businesses who pursue a cost-conscious company approach while offering a limited range of products will perform more effectively than those which fight on the basis of differentiating products and possess a greater variety of substances specifically, chemicals subject to control. According to a number of investigations, stronger ecological laws fosters technical innovations.

According to this hypothesis, environmental laws will enhance innovation and this will lead to lessening in costs and enhancement in quality of the environmental and this may cause domestic corporations to competitive advantages. Porter's approach is new in that it asserts that ecological safety measures do not always hurt businesses' bottom lines. Conversely, in certain cases it might be better for them because a well-crafted environmental legislation can increase businesses' competitiveness.

According to Porter and Van (1995), ecological regulations that are well-crafted can accomplish not less than six goals. Firstly, legislation alerts businesses regarding possible technical advancements and probable resources inefficiency. Businesses are continually learning how to measure their emissions, comprehend all the implications of inadequate resource usage and toxicities, and come up with novel strategies to limit emissions. Legislation draws emphasis to this possible creative sector. Secondly, by increasing business knowledge, regulations that are centered on collecting data may yield substantial advantages. For instance, 1986 ecological law renewal mandates that over 20,000 factories disclose their discharges of around 320 hazardous substances in Toxics Releasing inventory, that are made available yearly. This data collection frequently results in ecological enhancement without requiring cuts in emissions, and occasionally at significantly decreased expenses. Thirdly, legislation lessens the risk that ecological expenditures will prove worthwhile. Investing in all areas is encouraged by increased trust. Fourthly, legislation generates incentive that spurs advancement and creativity. In order to combat institutional stagnation, promote inventiveness, and lessen agency issues, the larger study regarding competitiveness emphasizes the essential function of external factors throughout the development of innovations. They contend that appropriately designed regulations may additionally provide this kind of stress. Economists respond to the idea that incentives for innovations could originate from powerful rivals, demanding

consumers, or increasing raw material costs. Sixth, legislation is required when there are insufficient offsets. Particularly in the near run when learning may decrease the expense of technology-based remedies, they easily acknowledge that creativity can never totally balance the expense of adherence. In these circumstances, legislation might be required to raise the standard of the environment.

Whether more stringent legislation improves corporate performance has divergent proof. It's unclear if market-driven methods to governance or mandates and bans actually have an influence. Although there exists conflicting actual data, economic hypothesis predicts that devices determined by consumer demand may be superior. Yet, irrespective of what kind of rules, an investigation regarding OECD nations revealed little proof for the long-term impact of regulatory stiffening on efficiency after the installation of environmentally friendly regulations.

The terms "weak version" and "strong version " of PH were additionally put forth by Jaffe and Palmer (1997). The first is true when environmental restrictions alone result in innovation, whereas the reverse is true when environmental rules also result in Policies support increased productivity. Varying conclusions have been reported by scholars on PH.

Ford et al. (2014) investigate how oil companies and gas companies in Australia have innovated in relation towards the difficulty of observing the environmental rules and also the unique traits of each company. According to the findings of this investigations, both legal provisions describe innovation within these industries. It is supported by survey results, senior leadership discussions, and session proceedings. The correlation between products and innovation and adherence cost is supported by this finding, which is in line with the outcomes of regression analysis conducted over the course of the investigation.

Alpay et.al. (2002). examined food manufacturing industries in Mexico, which was subject to rapidly expanding environmental laws during 1990s. The findings demonstrate that rising demands led to an increase in production. They discovered that mean of 2.8percentage rise with respect to the overall efficiency of factors was related to 10precent increase associated with the push for pollution legislation. Yet, it must be noted that ecological rules have a negative influence on profitability despite having a beneficial

effect upon factor efficiency as a whole. Nevertheless, it must be highlighted that American food business does not exhibit a comparable tendency; in effect, there has been significant proof that ecological regulations have a detrimental effect on production

Rubashkina et, al. (2015) confirmed the weak version of porter hypothesis in industrial area comprising 17 EU nations where laws of the environment stimulate patent claims instead of R and D expenses

According to several research investigations, environmental law which is more stringent encourages innovation (weak form). If stricter law improves corporate performance, the data is conflicting (strong form). Dechezlepretre, Sato (2017) stated that good environmental regulations may aid industries to use technologies that are friendly to the environment and this may cause a reduction in emissions.

Placing restrictions on industries conduct, strictness in ecological rules has a negative consequence on industries efficiency as well as competitiveness. For instance, when environmental laws raise obstacles, firms' entrance-exit processes slow down, and competing forces are lessened, the efficiency of the industries will decline. Environmental regulations that are too strict might also cause businesses that produce a lot of pollution to leave the country in order to avoid paying taxes (Rubashkina et al., 2015).

Kneller & Manderson (2012) look into impact of innovation upon the cost associated with pollution control. Using the statistics from United kingdom's manufacturing industries covering the period 2000 to 2006. They also expressly dealt with the possible endogeneity within their measurement of strictness of ecological rules. As revealed by findings, rising costs for reducing pollution drive ecological R&D as well as investments, yet no positive effect from ecological legislation upon the overall R&D nor capital formation. The researchers suggest that stricter environmental regulations are one factor that may have contributed to these outcomes. When policies are implemented properly, less money is spent on none environmental developments. They also found that, despite the lack of proof, ecological R&D may displace quasi R&D despite the lack of proof which it does so. Thus, according to study's results, a tenuous positive association exists between ecological policy with innovation, yet the data is still equivocal because there have only been just few investigations into the topic. Furthermore, the strategy is constrained by observation that, in spite of that, strict environmental restrictions

don't promote R&D efforts within industry subject to regulation, they could apply to the abatements equipment sector.

Using both methodologies, Lanoie et al. (2007) evaluates the entire Porter causation network for initial period. The information was obtained through a special OECD study of greater than four thousand businesses in 7 developed nations. The procedure entails evaluating 3 equations via going through two phases with sufficient**.** First, according to the findings, there exists a strong correlation between ecological innovations and how serious people view ecological rules to be; that finding is in conformity with said weak form of the Porter theory. The "anticipated" ecological innovations from the first analysis also possesses a favorable and substantial effect on corporate effectiveness. strong version of Porter theory suggests a causal relationship between law and innovations, which again improves organizational effectiveness. This finding supports this hypothesis. They do point out, though, that ecological legislation directly harms company performance. Overall, they reach the opinion that legislation itself has a detrimental net impact, even while innovation has a beneficial impact on corporate performance. In general, regulation is perceived as expensive, although it would be cheaper when one just only account for direct expenses of regulating itself. The crystal fact that the bulk of prior research did not sufficiently account for dynamic elements of PH is a significant limitation toward the negative outcome. Porter said that stricter environmental regulations will spur innovations which ultimately lower prices by reducing inefficiencies. This procedure could take a while. Investigators have frequently run regressions associated with productivity from time zero on measures of strictness of ecological regulations at that same time during earlier investigations on the factors that influence productivity, that fail to give innovation processes enough room to take place.

Stringent environmental legislations spur the development of greener technology and advancement in environment, the innovation effect which increases the efficiency of manufacturing procedures and end goods. The reduction in cost that can be realized are adequate to offset the expenses involved in innovation and that of the cost of direct compliance associated with the new rule ( Mrgus Wagna, 2003)..

The strong form, as Jaffe & Palmer (1995), divulged contends that businesses would not follow all lucrative possibilities to create new goods or procedures. This version

challenges the profitability model. The situation whereby new legislation might encourage businesses to explore more widely and discover fresh chances to boost company profits would be this one. Under such circumstances, regulation ends up becoming a free handout since it's beneficial in and of itself no matter what ecological issue this was intended to address. The reasoning behind the findings is their conviction that, in the context of rationality, regulations cannot provide economic benefits but then only expenses. As given by a different reading associated with strong form, in addition to ecological spillover, there could be additional issues as well as market flaws that restrict the ability of businesses to make their earnings, and government could be able to assist address such issues.

### 2.2.3 Pollution heaven hypothesis

According to this hypothesis, when major industrialized countries pursue to establish offices or factories in other countries, they frequently hunt for properties and labor intensive alternatives that provide the necessary opportunity to get land with other materials at lower costs. This frequently leads to actions that are harmful to the environment, though. Developing countries with low labor cost and resources typically have ineffective environmental rules. Conversely, countries with tighter environmental legislations are more costly for business due to the expenses involved in adhering to these values. As a result, businesses who decided to invest directly abroad frequently relocate to those nations having lowest standards of environment. The theory explains the notion that firms associated with pollution will move to regions having less restrictive environmental laws (M Scott Taylor, 2008). Trade makes developing nations with lax ecological regulations dirtier since these economies concentrate in making dirty commodities. There exist three main explanations for why underdeveloped nations establish lower requirements. To begin with, emerging economies generally have greater expenses associated with maintaining and upholding pollution regulations. This can be a result of, among other things (in contrast with industrialized nations), a lack of skilled employees, costly implementation expenses of fresh pollution limits, difficulties procuring current machinery plus corruption. Secondly, wealthy advanced economies create greater demands for fresh air and drinking water. Low-income

emerging nations prioritize additional revenue and employment over well-being and emissions. Thirdly, economic development in emerging nations means a switch from agricultural toward manufacturing, that prompts a quick upsurge in urban population and significant expenditures in infrastructural development in the urban areas, increasing pollution levels. In the, industrialized nations however, growth entails a switch from industry toward services, that lowers the degree of emissions.

Varying conclusions are reported by scholars on PHH. For instance, according to cole (2004) business associated with intense pollution experienced fast growth in developing nations the time the environmental laws in the economies of OECD were so stringent.

Dinta (2004) however rendered the PHH invalid when he pointed out that polluting firms that try to move to developing nations would cause the income of these countries to rise. Consequently, the host nations will also begin to impose strict environmental rules. Eventually, polluting firms will have nowhere to shuffle since there are strict environmental legislations everywhere.

List (2004) emphasized that a company's choice to relocate is influenced by a variety of variables, including labor prices, closeness to market, among others, in addition to the level of ecological legislation. Consequently, environmental rules must be separated from various other influencing elements in order to identify the presence of pollution heaven hypothesis.

According to Costantini & Mazzanti (2012), there is proof suggesting PH hypothesis that rules of the environmental boost global competitiveness as well as technical advancements out of broad set of global nations. They argued that ecological restrictions really weren't necessarily detrimental to industrial production, particularly when it came to tariffs of the environment and energy, which they said improved the competitiveness of exports. Environmentally friendly and high-quality goods will be produced by the competitors.

Utilizing data comprising 34 nations from 1965 -995, which represented almost 80 percent of the globe's exportation of ESGS during the period 1995, Xu (1999) investigates whether strict ecological standards lower the global competitiveness with respect to ESGS. The article's key testing result has been that, regarding the majority of

industrialized nations, export growth of ESGS (also known as "dirty" commodities) stayed steady between both the years 1960 and 1990, following the establishment of strict ecological standard during the years 1970 -1980.

India was used as an instance of emerging economy by Dietzenbacher et, al. (2004) to experimentally evaluate pollution heaven hypothesis. The researchers use the true shares of every product in total exportation of goods to determine the extent to which pollution would rise when exports were increased by 1 billion rupees. Utilizing the real product proportions in goods imported as calculation, the result is contrasted to reduced pollution resulting from a rise in the imports of the economy by 1billion rupees. The researchers discover that India benefits significantly from increased trade and therefore refute pollution heaven hypothesis under two alternative hypotheses for pollution through fossil fuels burning (pollution cause by manufacturing as well as pollution cause by consumption ) in Indian economy has gotten farther from becoming pollution havens, judging by the findings, since this benefits has just grown with time.

However, there are also some assumptions that opposed pollution heaven hypothesis.

- It really is asserted that businesses, when relocating to nations with loose environmental standards, also take into account the fact that pollution lowers workforce productivity, which may increase labor expense to a company.
- When a company decides to move its operations to some other nations, it also takes into account the significant sunk costs.
- The legal systems and business laws are typically feeble in nations with minimal environmental protections. however, the foreign investment from wealthy nations choose nations with good rules and unambiguous laws enforcing the rules. They will therefore probably stay away from investing in nations with low environmental regulations globe with various specifications, function examination, variables, methods of estimation, and datasets.
- The issue is fueled by the comparative advantage which growing economies undergo because of laxer environmental controls. The majority of the time, poor nations export specialized, contaminated goods and wealthy nations typically focus in exporting clean products. Consequently, developing nations are

contributing to pollution a sanctuary for the unclean industries of developed nations.

- The predominance of sectors that produce a lot of pollution in underdeveloped and growing economies, according to opponents of free trade, is the result of lax environmental regulations in these nations. They contend that customers in wealthy nations receive items with high levels of pollution at reduced costs as a result of the undervaluation of natural resource in growing economies. PHH refers to the phenomena of the grouping of manufacturing industries that produce large amounts of pollution in developing and underdeveloped nations.

### 2.3 Conceptual framework (conceptual model)

A conceptual model refers to a diagram that serves to show how the cause and the effect should typically be related. The framework includes a variety of parameters and reflects the predictions by taking into account the presumptions about their connections. This structure is an instrument which is employed before a research. As a result, a conceptual model functions as an analysis unit. Solid conceptual foundations enable the achievement of targeted goal. It functions as a pathway for the investigation, assisting in visualizing and carrying out the task. It lists the pertinent parameters for the research and illustrates potential relationships between them. Here, the dependent variable is environmental quality and the independents variables are green finance, environmental policy stringency, environmental technical innovation, economic growth and industrial

struct

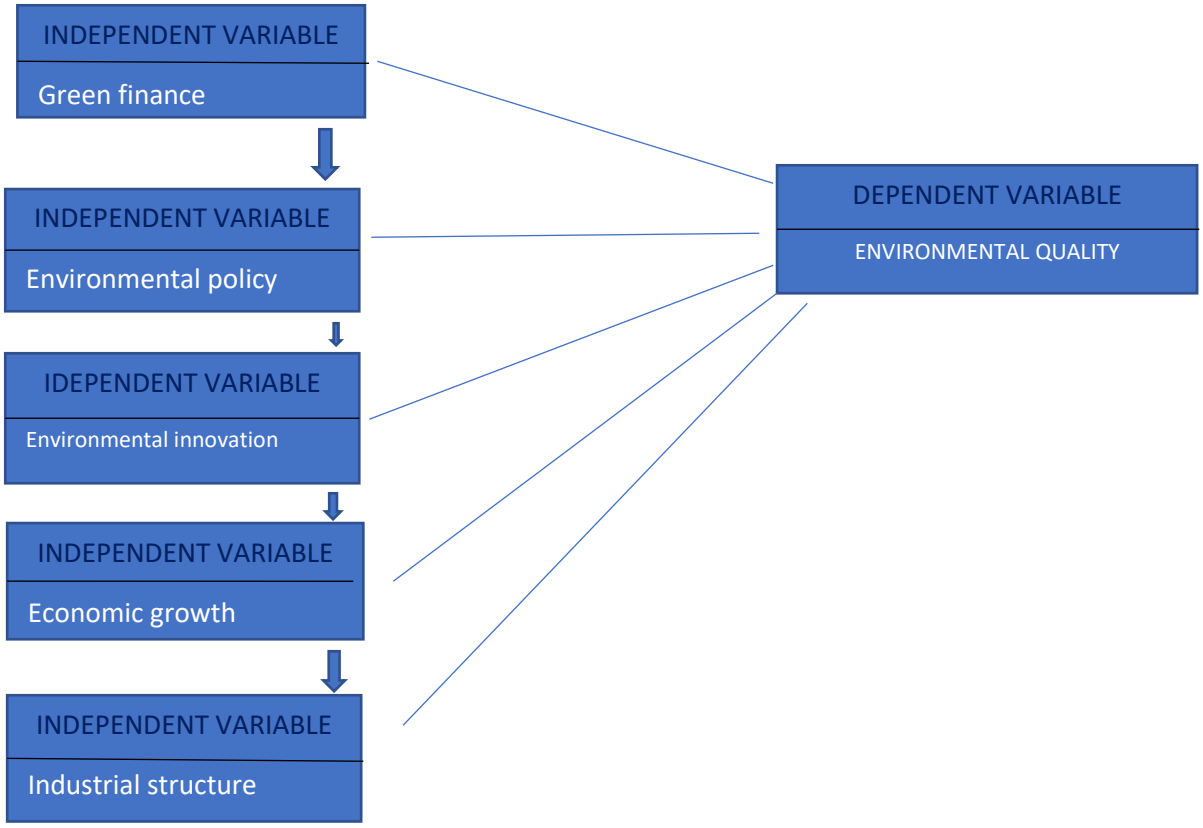



**Figure 3 Conceptual Framework**

# CHAPTER III

# Methodology

## 3.1 Introduction.

This chapter scrutinizes the impacts of green finance, economic growth, environmental technical innovation, environmental policy stringency and industrial structure on environmental quality in 15 OECD countries which are France, Ireland, Finland, New Zealand, Netherland, Belgium, Sweden, Canada, Austria, Germany, United Kingdom, Switzerland, Spain, Norway and Denmark. Here, the econometric methods are utilized in determining the influences of the independent variables on the dependent variable. The study's variables are also given brief description.

## 3.2 Data collection and sources

This investigation utilizes secondary data from the previous literatures. This paves the way for evaluations to be made between the investigations that had been done previously and the investigation at hand. The investigation has five independent variables which are green finance, economic growth, environmental technical innovation, environmental policy stringency and industrial structure. The parameters' data are got from the OECD, WB (world bank) and IRENA. The investigation uses panel data which is obtained from secondary sources to scrutinize the impact of the study's parameters on environmental quality in 15 OECD economies. The investigation's sample size comprises data collected between the period 2000 to 2018. These 15 OECD economies are chosen on the basis of two factors. Firstly, these economies have shown significant improvement and commitment in structuring a low carbon future as revealed by green finance index report (2022). Secondly, the availability of data on the chosen economies is also another factor.

## 3.3 Variable description

Environmental quality- It gauges how well an ecosystem meets the needs of man and other organisms living in the environment. The quality of environment comprises factors like noise, quality of water, air and many other factors that may affect mankind

and other living creatures in the environment. The LCF is used as a proxy of environmental quality.

Green finance is defined as all investments and financing activities that consider ecological consequences and promote ecological sustainability. It encompasses all investments that are made to increase the integrity of the ecosystem.

Economic growth-refers to the rise in the production ability of a country in relation to her products on a comparative basis between two time periods after accounting for inflation

Environmental technical innovation- refer to institutional initiatives and modifications with an emphasis on the ecosystem, with varying degrees of originality that have an impact on goods and services, processes of production and advertising of businesses. The fundamental goal is to lessen the firm's ecological impacts, which can be achieved by simple incremental changes that enhance what is already there or drastic one that push something wholly novel. Also, there exists a positive bond between ecological innovation and how actively corporations manage their environmental impact.

Environmental policy stringency refers to the organization's or government' entire environmental goals and guiding principles, which may include adhering to all applicable environmental legislative compliance as well as a dedication to continuously improving the performance of the ecosystem.

Industrial structure- Industrial structure- it represents the key composition of the nation's socioeconomic production grouped as extractive, secondary and tertiary industry.

Here is the function below:

LCF= f (GF, EPS, ETI, GDP, INDS)

(1)

Where:

LCF denotes load capacity factor. It is utilized as a measure of environmental quality.GF, stands for green finance, GDP means gross domestic product. It is utilized as a measure for economic growth. ETI means environmental technical innovation, EPS denotes environmental policy stringency and INDS represents industrial structure.

Econometrically, this can be represented as shown below:

$$Lcf_{it} = \beta_0 + \beta_1 lngf_{it} + \beta_2 lnEp_{it} + \beta_3 lnEti_{it} + \beta_4 lnEg_{it} + \beta_5 lnIds_{it} + \mu_{it} \quad (2)$$

$Lcf_{i,t}$ means load capacity factor and it is utilized as a proxy for environmental quality. It is measured by dividing the biocapacity by ecological footprint (EF). $lnGf_{i,t}$ stands for green finance. This is measured by the climate related development finance commitment current US dollar. $lnEps_{i,t}$ means environmental policy stringency. It is gauged by the index of stringency environmental policy. $lnEtiI_{i,t}$ represents environmental technical innovation and it is measured by the number of patent trends of technologies that enabled further growth of renewable energy technologies. $lnEg_{i,t}$ stands for economic growth and it is calculated by Per capital GDP (Constant 2015 US$. $lnIndsS_{i,t}$ denotes industrial structure and is measured by Industry (including construction), value added (Annual % of growth) Table 1 depicts the variables and their data sources.

| **Variables** | **Symbol** | **Source** | Measurement unit |
|---|---|---|---|
| | | | |
| **Load capacity Factor** | LCF | Calculations | Biocapacity divided by ecological footprint |
| **Green finance** | GF | OECD | Climate-related development-finance-commitment-current USD thousand |
| **Environmental Technical innovation** | ETI | IRENA | Number of<br>Patent trends of technologies that enabled further growth of renewable energy technologies |
| **Environmental policy stringency** | EPS | OECD | Index of stringency environmental policy |
| **Economic growth** | EG | WDI | Per capita GDP (constant 2015 US$ |
| **Industrial structure** | IS | WDI | Industry (including construction) value added (annual % of growth) |

**Table 1 Data table**

### 3.4 Description statistics

This deals with the summarization of the gathered data in a more meaningful manner. Inferential statistics helps us understand the characteristics of the data. Descriptive statistics is mostly employed in quantitative research investigations. This investigation utilizes the data from the period 2000 to 2020 and utilizes LCF as a proxy of environmental quality and the independent variables which include the utilization of green finance, economic growth, environmental technical innovation, environmental policy stringency and industrial structure in 15 OECD economies using descriptive statistics.

### 3.5 Cross-sectional dependency test (CSD)

The investigation utilizes the CSD in determining the suitable methodologies of econometrics to be utilized. The findings of CSD assist in determining when to utilize 1st or 2nd order panel data analysis. The outcomes of an investigation would be unreliable, untrustworthy, skewed, prejudiced and futile unless CSD test is done (Bekum et, al.2020, Dong et, al. 2018, He et, al. 2021, Nathaniel et, al. 2020). The investigation employs Pesaren 2007, 2015 scaled LM.

### 3.6 Panel Unit root test

The outcomes produced by the 1st order unit root estimations are subjected to inefficiencies in cross section dependence. Due to this reason, this investigation utilizes the 2nd order unit root estimations advanced by Pesaran (2007). The investigation utilizes CIPS to investigate the issue of unit root. Additionally, in checking the robustness of CIPS unit root estimations, the investigation too utilizes the CADF unit root estimation. Hansen (1995) first posited this CADF analysis, which is based upon the notion that the actual economic events are often non univariate. As a result, utilizing more and more information during unit root analysis can improve the efficiency of tests regressions and enable more accurate inference. The investigation employs CADF and CIPS unit root tests because of the reliability of the outcomes they generate. The CIPS equation is depicted below:

$$\Delta Y_{it} = \Delta\emptyset_{it} + \beta_i X_{it} + \gamma_{iT} + \sum_{j=1}^{n} \varphi_{ij} \Delta X_{i,t-j} + \mu_{it} \quad (3)$$

### 3.7 Slope heterogeneity test

In testing for slope heterogeneity in the data, the investigation uses the Pesaran and Yamagata (2008). In addition, Blomquist and Westerlund (2013) heterogeneity test is also performed to scrutinize the robustness of the findings of the first test.

### 3.8 Panel cointegration test

Cointegration is the examination of the presence of a long run bond between a study's parameters. This study employs Johansen cointegration test to look into the long-term correlation between the parameters under the investigation. In addition, in checking the robustness the outcomes of the Johansen cointegration test, the investigation also uses the Westerlund (2008) panel cointegration test. These cointegration tests are performed as a result of the reliability of the outcomes. The calculations of the westerlund cointegration test are as shown below:

$$\Delta y_{it} = \gamma_i d_t + \theta_i y_{it} + \sum_{j=1}^{pi} \emptyset_{ij} \Delta y_{it-1} + \sum_{j=0}^{pi} \pi_{ij} \Delta x_{it-j} + \varepsilon_{it} \quad (4)$$

Where, $\gamma_i = (\gamma_i 1,\ \gamma_i 2)'$, refers to parameter's vectors, $d_t = (1\ , t)'$ denotes deterministic mechanism whereas $\emptyset$ means error correction parameter. To sense the presence of the long-term linkage, 4 estimations are constructed upon OLS technique of $\emptyset_i$ in the 4th equation. These equations are as follow:

$$\mathrm{G}_\tau = \frac{1}{\mathrm{N}} \sum_{i=1}^{N} = \frac{\text{^}\propto i}{SE(\text{^}\propto i)} \quad (5)$$

$$\mathrm{G}_\alpha = \frac{1}{N} \sum_{i=1}^{N} \frac{\mathrm{T}\text{^}\propto i}{\text{^}\propto i(1)} \quad (6)$$

$$\mathrm{P}_\tau = \frac{\text{^}\propto i}{SE(\propto i)} \quad (7)$$

$$\mathrm{P}_\alpha = \mathrm{T}1\alpha\text{^} \quad (8)$$

### 3.9 ARDL model

In the scrutiny of the long-term and short-term linkage between the study' variables, the investigation uses the panel ARDL model by Pasaran (2001). The model is a better one relative to others especially when the variables gain stationarity at I (0), I (1) or a joint of both. There are two processes in panel ARDL technique to cointegration when it comes to predicting a long-term linkage. Investigating whether there exists a long-term linkage between the factors constitutes the initial stage. The next procedure involves estimating the long run co-efficients using the outcomes of the panel ARDL model whether there exists a long-term linkage between the parameters. It is claim that in order to put on this strategy to data which is panel cross-equations limitations to the long-term variables should be introduced. The equation of the ARDL on the basis of the first equation is shown as follows:

$$\Delta lnLCF_{it} = \theta_0 \ + \sum_{i=1}^{q} \rho_1 \Delta lnLCF_{t-j} + \sum_{i=1}^{f} \rho_2 \Delta lnGF_{t-j} + \sum_{i=1}^{f} \rho_3 \Delta lnEPS_{t-j} + \sum_{i=1}^{f} \rho_4 \Delta lnETI_{t-j} + \sum_{i=1}^{f} \rho_5 \Delta lnEG_{t-j} + \sum_{i=1}^{f} \rho_6 \Delta lnINDS_{t-j} + \pi_1 lnLCF_{2t-j} + \pi_2 lnGF_{t-1} + \pi_3 lnEPS_{t-1} + \pi_4 lnETI_{t-1} + \gamma_5 lnEG_{t-1} + \gamma_6 lnINDS_{t-1} + \omega ECT_{t-1} + \in_{it} \quad \textbf{(9)}$$

### 3.10 Granger causality test

The test was first introduced by clive granger (1969). The employed the technique to check if a linear relationship is two-way directional, one-way directional or non-directional. It helps in spotting if one variable is helpful in envisaging another variable. When parameter X causes parameter Y but Y causes not X, we then will have a unidirectional linkage between the two. A relationship between X and Y becomes bidirectional when both X and Y cause each other. The correlation between X and Y becomes nondirectional when X does not cause Y nor does Y cause X. He further stated that one method of evaluating causation in the field of economics is to gauge how well one variable can be predicted based on data from another variable. It states that when a time series X1 causes time series X2, then the previous values for X1 must have information which contributes thereto X2's prediction in addition to which is provided by X2's previous value. The equations of the Granger causality test are given as follow:

$$\Delta \boldsymbol{lnLCF_{it}} = \alpha + \sum_{\boldsymbol{i=1}}^{\boldsymbol{p-1}} \boldsymbol{\varsigma_i} \Delta \boldsymbol{lnLCF_{t-i}} + \sum_{j=1}^{q-1} \omega_j \Delta lnGF_{t-j} + \sum_{m=1}^{q-1} \vartheta_m \Delta lnEPS_{t-m} + \sum_{l=1}^{q-1} \Theta_l \Delta lnETI_{t-l} + \sum_{r=1}^{q-1} \xi_r \Delta lnEG_{t-r} + \sum_{n=1}^{q-1} \pi_n \Delta lnINDS_{t-n} + \lambda_1 ECT_{t-1} + \epsilon_{1t} \quad \textbf{(10)}$$

$$\Delta \boldsymbol{lnGF_{it}} = \alpha + \sum_{i=1}^{p-1} \varsigma_i \Delta lnLCF_{t-i} + \sum_{j=1}^{q-1} \omega_j \Delta lnGF_{t-j} + \sum_{\boldsymbol{m=1}}^{\boldsymbol{q-1}} \boldsymbol{\vartheta_m} \Delta \boldsymbol{lnEPS_{t-m}} + \sum_{l=1}^{q-1} \Theta_l \Delta lnETI_{t-l} + \sum_{r=1}^{q-1} \xi_r \Delta lnEG_{t-r} + \sum_{n=1}^{q-1} \pi_n \Delta lnINDS_{t-n} + \lambda_3 ECT_{t-1} + \epsilon_{1t} \quad \textbf{(11)}$$

$$\Delta \boldsymbol{lnEPS_{it}} = \alpha + \sum_{i=1}^{p-1} \varsigma_i \Delta lnLCF_{t-i} + \sum_{j=1}^{q-1} \omega_j \Delta lnGF_{t-j} + \sum_{\boldsymbol{m=1}}^{\boldsymbol{q-1}} \boldsymbol{\vartheta_m} \Delta \boldsymbol{lnEPS_{t-m}} + \sum_{l=1}^{q-1} \Theta_l \Delta lnETI_{t-l} + \sum_{r=1}^{q-1} \xi_r \Delta lEC_{t-r} + \sum_{n=1}^{q-1} \pi_n \Delta lnINDS_{t-n} + \lambda_3 ECT_{t-1} + \epsilon_{1t}$$

**(12)**

$$\Delta \boldsymbol{lnETI_{it}} = \alpha + \sum_{i=1}^{p-1} \varsigma_i \Delta lnLCF_{t-i} + \sum_{j=1}^{q-1} \omega_j \Delta lnGF_{t-j} + \sum_{m=1}^{q-1} \vartheta_m \Delta lnEPS_{t-m} + \sum_{\boldsymbol{l=1}}^{\boldsymbol{q-1}} \boldsymbol{\Theta_l} \Delta \boldsymbol{lnETI_{t-l}} + \sum_{r=1}^{q-1} \xi_r \Delta lnEG_{t-r} + \sum_{n=1}^{q-1} \pi_n \Delta lnINDS_{t-n} + \lambda_4 ECT_{t-1} + \epsilon_{1t}$$

**(13)**

$$\Delta \boldsymbol{lnEG_{it}} = \alpha + \sum_{i=1}^{p-1} \varsigma_i \Delta lnLCF_{t-i} + \sum_{j=1}^{q-1} \omega_j \Delta lnGF_{t-j} + \sum_{m=1}^{q-1} \vartheta_m \Delta lnEPS_{t-m} + \sum_{l=1}^{q-1} \Theta_l \Delta lnETI_{t-l} + \sum_{\boldsymbol{r=1}}^{\boldsymbol{q-1}} \boldsymbol{\xi_r} \Delta \boldsymbol{EG_{t-r}} + \sum_{n=1}^{q-1} \pi_n \Delta lnINDS_{t-n} + \lambda_5 ECT_{t-1} + \epsilon_{1t}$$

**(14)**

$$\Delta \boldsymbol{lnINDS_{it}} = \alpha + \sum_{i=1}^{p-1} \varsigma_i \Delta lnLCF_{t-i} + \sum_{j=1}^{q-1} \omega_j \Delta lnGF_{t-j} + \sum_{m=1}^{q-1} \vartheta_m \Delta lnEPS_{t-m} + \sum_{l=1}^{q-1} \Theta_l \Delta lnETI_{t-l} + \sum_{r=1}^{q-1} \xi_r \Delta lnEG_{t-r} + \sum_{\boldsymbol{n=1}}^{\boldsymbol{q-1}} \boldsymbol{\pi_n} \Delta \boldsymbol{lnINDS_{t-n}} + \lambda_6 ECT_{t-1} + \epsilon_{1t}$$

**(15)**

# CHAPTER IV

## Results and discussions

### 4.1 Introduction

This chapter presents the findings of the varying econometric procedures that the investigation uses in the analyzation of the data. The discoveries of every tool described in chapter 3 above is brought forth in this chapter where they are also interpreted. Here, the investigation divulges the impact of green finance (GF), environmental policy stringency (EPS), environmental technical innovation (ETI), economic growth (GDP) and industrial structure (INDS) on environmental quality in both short-term and long-term from the period 2000 to 2018. This is done via the employment of the PARDL to get the long run and short run co-efficients.

### 4.2 Descriptive statistics

This is concerned with the summarization of the gathered data in a fashion wherein it becomes more meaningful. It aids the investigators to better comprehend a data at hand. It acts as the beginning phase with respect to the analyzation of a study's data aiding the investigators in data organization, simplification and summary.

Table 2 depicts the outcomes of decriptive statistics. It is noticed that green finance finance has and average growth rate of 11.391 with a devation from the sample mean of 2.218. Environmental policy stringency has an average of 0.888 with a standard deviation of 0.510, environmental technical innovation with a mean of 2.302 with a satandard deviation of 0.362, economic growth having and average growth rate of 10.701 and insustrial structural with a mean of 3.183 with a standard deviation of 0.186. This statistic divulged that the deviation of each of the series from the sample mean is low. The decoverise also depict the median values of the parameters wherein LCF possesses a median value of 0.522, GF 11.674, EPS 1.041, environmental technical innovation (ETI) 2.350, EG 10.665 and industrial structure 3.180. The value of maximum value of LCF is 2.192 and the minimum value is 0.111. Green finance, EPS, environmental technical innovation, economic growth and industrial structure have maximum values of 15.897, 1.516, 3.252, 11.371 and 3.696 respectively and minimum values of 2.659, -1.186, 0.863,

10.083 and 2.844 respectively. The Jarque bera statistics reveals that the data is not normally distributed. This is backed by the crystal fact that the entire probablitis fall under 5%. In terms of skewness, LCF, GDP and structural structure are positively skewed while green finance (GF), environmental policy stringency (EPS) and environmental technical innovation (ETI) are negatively skewed.

Kurtosis which shows how much the information within point estimates associated a specific distribution diverge from those of a normally dispersed data . It can also be used to check for the presence of extreme numbers in distributions. It gauges how many tails there are in the concerned distribution .The kurtosis values indicate that LCF and industrial structure are platykurtic and green finance, environmental policy stringency, environmental technical innovation and economic growth are leptokurtic.

**Table 2, Descriptive statistics estimations**

| Variables | LCF | LGF | LEPS | LETI | LGDP | LINDS |
|---|---|---|---|---|---|---|
| **Mean** | 0.713 | 11.391 | 0.888 | 2.302 | 10.701 | 3.183 |
| **Median** | 0.522 | 11.674 | 1.041 | 2.350 | 10.665 | 3.180 |
| **Maximum** | 2.192 | 15.897 | 1.516 | 3.252 | 11.371 | 3.696 |
| **Minimum** | 0.111 | 2.659 | -1.186 | 0.863 | 10.083 | 2.844 |
| **Std. Dev.** | 0.600 | 2.218 | 0.510 | 0.362 | 0.275 | 0.186 |
| **Skewness** | 1.003 | -0.503 | -2.171 | -0.332 | 0.479 | 0.411 |
| **Kurtosis** | 2.534 | 3.178 | 8.358 | 3.718 | 3.399 | 2.797 |
| **Jarque-Bera** | 50.374 | 12.380 | 564.784 | 11.366 | 12.772 | 8.527 |
| **Probability** | 0.000 | 0.002 | 0.000 | 0.003 | 0.002 | 0.014 |
| **Sum** | 203.252 | 3246.393 | 253.036 | 656.130 | 3049.835 | 907.141 |
| **Sum Sq. Dev.** | 102.387 | 1396.898 | 73.757 | 37.312 | 21.554 | 9.833 |
| **Observations** | 285 | 285 | 285 | 285 | 285 | 285 |

**Source: Author's computations.**

The findings of CSD depicted in table 3 divulged that there exists cross sectional dependence in the model.

**Table 3 CSD estimation**

| Variables | CD-Test | P-Value |
|---|---|---|
| LCF | 11.03 | 0.000 |
| GF | 28.48 | 0.000 |
| ETI | 35.73 | 0.000 |
| EPS | 38.72 | 0.000 |
| GDP | 38.29 | 0.000 |
| INDS | 27.04 | 0.000 |

### 4.3 Panel unit root test

This investigation also looks into stationarity of the parameters under the study. This empirical research investigation desires the utilization of the CADF unit root test and CIPS unit root test in accounting for homogeneity problem. As a result of the inefficiencies associated with the outcomes of 1$^{st}$ order unit root test, the 2$^{nd}$ order unit root tests like the CADF unit root test and CIPS unit root test are ideal for the investigation. This is because of the fact that CIPS and CADF panel unit root estimations are superior to 1$^{st}$ order unit root estimations such as ADF and PP. Therefore, to produce a reliable result, the investigation utilizes CIPS and CADF to accurately look into the study's variables stationarity.

The outcomes of panel CIPS and CADF are presented in table 3. If the F-statistic of a variable is less than the critical value at level for CIPS unit root estimation, the first-difference is looked for. As for the CADF unit root estimation if the P-value is not significant at 1%, 5% or 10%, the first difference is looked for. The findings reveal that LCF is not stationary at level. It though becomes stationary at first difference for both CIPS and CADF estimations. The findings also reveal the non-stationarity of GDP at level. It also becomes stationary at 1$^{st}$ difference. Additionally, the results show that green finance, environmental policy stringency, environmental technical innovation and industrial structure all become stationary at level for both CIPS and CADF estimations.

**Table 3 Unit root estimations**

| CIPS UNIT ROOT ESTIMATIONS | | | | |
|---|---|---|---|---|
| **Variable** | **LEVEL** | | **1ST DIFFERENCE** | |
| | **F-Stat** | **CV** | **F-Stat** | **CV** |
| LCF | -2.367 | -2.45 | -5.19 | -2.45 |
| LGF | -2.972 | -2.45 | - | - |
| LEPS | -2.938 | -2.45 | - | - |
| LETI | -3.605 | -2.45 | - | - |
| LGDP | -0.932 | -2.45 | -2.382 | -2.26 |
| LINDS | -2.664 | -2.45 | - | - |
| **CADF UNIT ROOT ESTIMATIONS** | | | | |
| **Variable** | **LEVEL** | | **1ST DIFFERENCE** | |
| | **F-Stat** | **P-Value** | **F-Stat** | **P-value** |
| LCF | -2.062 | 0.118 | -3.518 | 0.000 |
| LGF | -2.972 | 0.000 | - | - |
| LEPS | -2.938 | 0.000 | - | - |
| LETI | -3.605 | 0.000 | - | - |
| LGDP | -0.932 | 1.000 | -2.382 | 0.008 |
| LINDS | -2.664 | 0.000 | - | - |

**Note: F-stat= F-statistics, P-value= probability value. Source: author's computations**

### 4.4 Slope heterogeneity test

Table 4 depicts the outcomes of slope heterogeneity test. The findings of Pesaran and Yamagata (2008) are significant statistically for both delta and adjusted at 1% significance level. However, the results of Blomquist and Westerlund (2013) are statistically significant at 1% significance level for adjusted delta and 5% significance level for delta.

**Table 4 Testing for slope heterogeneity estimations**

| **Pesaran, (Yamagata. 2008.)** | | |
|---|---|---|
| | | p-value |
| Delta | 7.884 | 0.000 |
| adj. Delta | 10.020 | 0.000 |
| **Pesaran, (Blomquist, Westerlund. 2013)** | | |
| | | p-value |
| Delta | 2.146 | 0.032 |
| adj. Delta | 2.727 | 0.006 |

**Note: source author's findings**

### 4.5 Panel cointegration test

The investigation also explores the long run linkage between the parameters. Since the model is affected by the problem of slope heterogeneity, the 2nd order unit root tests are utilized. This points out the that the parameters possess unit root at level.

The investigation utilizes the Johansen Fisher panel cointegration test and Westerlund (2008) test to show the long-term correlation between the parameters. These panel cointegration tests are utilized because of the reliability of the outcomes. The outcome of Johnsen Fisher panel cointegration test is presented in table 5. The findings divulge the existence of at most four (4) cointegration equations. The HO that there exists no cointegration equations is refuted and the H1 that the parameters are cointegrated is accepted.

In addition, the findings of Westerlund (2008) cointegration test shown in table 6 also approves the existence of cointegration equations.

**Table 5 Johansen Fisher Panel Cointegration Test estimations**

| **No. of CE(s)** | **Trace test** | **Max-eigen test** | **Prob.** |
|---|---|---|---|
| None | 123.0 | 123.0 | 0.000 |
| At most 1 | 619.3 | 393.1 | 0.000 |
| At most 2 | 316.1 | 212.8 | 0.000 |
| At most 3 | 151.2 | 115.4 | 0.000 |

| | | | |
|---|---|---|---|
| At most 4 | 71.4 | 69.0 | 0.000 |
| At most 5 | 29.7 | 29.7 | 0.484 |

**Table 6 Westerlund ECM panel cointegration tests**

| Statistic | Value | Z-Value | P-Value | Robust P-value |
|---|---|---|---|---|
| Gt | -3.534 | -2.183 | 0.015 | 0.140 |
| Ga | -5.873 | 5.627 | 1.000 | 0.010 |
| Pt | -18.089 | -7.329 | 0.000 | 0.020 |
| Pa | -4.602 | 4.756 | 1.000 | 0.210 |

**Note: source, author's computations**

### 4.6 Panel ARDL estimations

**Table 7** depicts the results of panel ARDL estimations. The findings show the positive co-efficient (0.005) of GF on LCF at 1% significant level in the long-run. This depicts that in the long-run, a 1% upsurge in GF will result to a 0.005% increase in the environmental quality of OEDC nations. This result is endorsed by the previous literatures such as (Li and Jia 2017, Meo and Karim 2022). This outcome reveals that green finance is pivotal in enhancing ecological sustainability in the OECD. This finding additionally confirms that the OECD GF initiatives are highly effective in fostering environmental quality. Through the utilization of ecologically friendly technologies, businesses are capable of implementing green initiatives that lessen environmental harm and maintain the quality of the environment. With its financial role in the OECD, GF improves greenhouse gas emission effectiveness. Green businesses can completely deploy social value by issuing green bonds, as well as other GF goods. At this point, the development of green bonds promotes investments in green goods, enhances businesses' capacity to run sustainably, and support the ongoing development of an ecologically friendly industrial sector of a nation. Green financing, which supports technical advancement, can bring forth green change in industries. green financing has the power to motivate businesses to carry out innovative green initiatives and advance technology. The results from this investigation further demonstrate why green financing is indeed a method for fostering

the usage of clean sources of energy while also fostering financial advancement which is ecologically sound. This indicates that green finance enhances consumer wellbeing by promoting financial stability and boosting the utilization of renewable sources of energy, thereby increasing ecological integrity. Green finance also reduces the usage of nonrenewable sources of energy by exposing individuals to financing options, which enhances mankind's welfare and promotes ecological sustainability. Green funding furthermore, increases both governments and private sectors funding for ecological sustainability. This fosters the growth of green ecosystem by considerably minimizing emissions.

In addition, the long- results reveal the negative co- efficient (-0.081) of EPS with LCF. This becomes significant at 1% significance level. It shows that in the long-run, if EPS increases by 1% environmental quality of the OECD countries will diminish by 0.081. This points out that the OECD governments' environmental policies do not boost the quality of their environments but rather decays it. Environmental policy measures which are designed to attainable environmental health is therefore not a good weapon for the OECD nations. This outcome is not confirmed by past studies like (Ahmad et, al. 2018, K. Du et, al. 2019) both of who concluded environmental policy stringency to be a good weapon in fostering environmental health in the economy of china by lowering emissions. Moreover, as show in table 7, ETI possess a positive co-efficient of 0.097 of ETI on environmental quality at 1% significant level in the long-run. This indicates that when ETI rises by 1%, the environmental quality of OECD nations will be enhanced by 0.097% in the long- run. This empirical finding indicates the crucial role of environmental technical innovations in enhancing the environmental quality of the OECD countries. It indicates that environmental technical innovation is a powerful weapon in the fight against ecological depletion. The result is in agreement with the previous literatures such as (Mensa 2019, Balsalobre 2015). Technology advancements can considerably raise environmental quality by utilizing energy resources more effectively and by advancing technology. The result postulates that the OECD governments have taken the right step in fostering their environmental quality through undertaking investments in innovations that are intended to improve environmental sustainability. By increasing the effectiveness of manufacturing processes and changing energy patterns, the encouragement of technical

innovations could aid when it comes to carbon dioxide emissions reduction. The advancement of technology, especially those that are relevant to the ecosystem, is encouraged by improved ecological strategies. Ecological enhancement will be well boosted by putting more emphasis on energy technological innovations that are conscious of the ecosystem. Fossil fuels, whose consumption diminishes environmental health, will be replaced with eco-conscious sources of energy which would lead to an immense minimization of environmental harms such as pollution. Furthermore, by minimizing waste productions, water usage and contaminants, technological innovations could greatly boost environmental integrity generally. Chiefly, in the industrialized parts of the globe a profound expansion in eco-friendly technological innovations is witnessed in the previous few years. Due to the friendliness these innovations show towards the ecosystem, the investigators have seen a decline in ecological depletion.

Furthermore, the findings present that at 1% significance level, GDP has a negative co-efficient (-0.446) on environmental quality in the economies of OECD in the long-run. This means that in the long-run, when there is a 1% increase in GDP, the OECD economies will experience a 0.446% reduction in environmental quality. The result is in conformity with the past studies such as (Baz et, al. 2020, Hassan et, al. 2019, Saud et, al. 2019). This outcome indicates that economic expansion in the OEDC results to worsening environmental quality which can be due to extreme usage of fossil fuels in the process of production. The ecosystem is put under increasing stress due to increased usage of naturally endowed resources and C02 emissions. People neglect the negative effects of excessive pressure on the environment or they are so impoverished to make payments that can reduce environmental depletion. Furthermore, GDP expansion generates pollutants and long-run wastes, leading to unintended repercussions. For instance, GDP expansion has driven up the usage of plastics, that are non-degradable once rid of. Therefore, rising amount of plastics found in our surroundings as well as oceans is constantly growing, that looks ugly and also harmful to species**.** Resources are depleted and wildlife is lost as a result of GDP expansion. This might reduce a nation's ability to carry through to the near future. While the value of destroyed genomic data may not be fully understood, there exists ambiguity regarding the amount of such a price.

Still on, at 1% significant level, the long-run outcomes show that INDS has a negative co-efficient (-0.218) on environmental quality. This presents that in the long- run, a 1% upsurge in INDS results to a 0.218% decline in the environmental quality of OECD countries. This empirical outcome shows that there exists a long-term negative bond between industrial structure and environmental quality in the countries of OECD. This outcome is in line with the previous studies like (Cia and Li 2009, Liu 2021) This empirical result divulges that there are still ecologically unfavorable machines and technologies that are utilized in the process of production. Industries are associated with excessive ecological pollution especially in economies where the extractive and secondary productions dominate due to fact that these industries consume a lot of energy. The utilization of fossil fuels by traditional manufacturing industries during the varying phases of production intensifies the emission of $CO_2$ resulting to extreme decline in ecological integrity. There arises a necessity for the nations of OECD to change the system of industries from the ecologically-unfriendly industries to ecologically friendly ones.

**Table 7 PARDL long-run estimations**

| Variable | Coefficient | Std. Error | t-Statistic | P-Value |
|---|---|---|---|---|
| **LGF** | 0.005 | 0.001 | 7.023 | 0.000 |
| **LEPS** | -0.081 | 0.005 | -14.950 | 0.000 |
| **LETI** | 0.097 | 0.004 | 22.054 | 0.000 |
| **LGDP** | -0.446 | 0.027 | -16.681 | 0.000 |
| **LINDS** | -0.218 | 0.010 | -21.704 | 0.000 |

**Note, Source: author' computations**

The findings of the short-run panel ARDL are presented in table 8. As divulged by the outcomes, GF has a positive co-efficient (0.001) on environmental quality but this is insignificant in the short-run. This points out that the impact of green finance on environmental quality in OECD economies is not immediate and it takes a while before the impact is felt on the environment.

Additionally, the results also point out the short-run positive co-efficient (0.131) of EPS on environmental quality in the OECD nations. However, this influence of EPS on environmental quality is not significant in the short-run.

The short-run findings also present that ETI has a negative co-efficient (-0.003) with LCF but this is insignificant. This implies that in the short-run environmental technical innovation has a negative and insignificant effect on the environmental quality of OECD countries.

Furthermore, the short-run estimations also depict the negative co-efficient (0.747) of GDP on environmental quality. However, this influence is insignificant during the short run. This divulges that EG in the short-run negatively and insignificantly affects the environmental quality in the OECD economies.

Moreover, the short-run outcomes report the negative co-efficient (-0.334) of INDS on environmental quality. This is significant at 1% significance level. This indicates that in the short-run, a 1% surge in the INDS leads to a 0.334% reduction in environmental quality of OECD countries. The findings for both short-run and long-run panel ARDL indicate that industrial structure negatively impacts the ecological quality of the OECD nations. This can be attributed to the excessive utilization of fossil fuel by some developing economies among OECD nations in producing commodities in their industries.

The ECT has a significant negative co-efficient (-0.790). It reveals the long-term linkage amongst the parameters. The larger ECT's value, the quicker the speed of attaining the long-term balance. The co-efficient reveals that for there to be long-term balance, the disruptions in short-term would have to be repaired at 79%.

**Table 8 PARDL short-run estimations**

| Variable | Coefficient | Std. Error | t-Statistic | Prob.* |
|---|---|---|---|---|
| **ECT(-1)** | -0.790 | 0.156 | -5.063 | 0.000 |
| **D(LGF)** | 0.001 | 0.008 | 0.064 | 0.949 |
| **D(LEPS)** | 0.131 | 0.127 | 1.034 | 0.304 |
| **D(LETI)** | -0.003 | 0.028 | -0.090 | 0.928 |
| **D(LGDP)** | -0.747 | 0.931 | -0.802 | 0.424 |
| **D(LINDS)** | -0.334 | 0.112 | -2.979 | 0.004 |
| **C** | 4.764 | 0.949 | 5.018 | 0.000 |

**Note: source: author's computations**

### 4.7 Granger causality test

Table 9 depicts the outcomes of Granger causality estimations. These outcomes have three possible interpretations. An outcome becomes unidirectional when one independent variable possesses an impact on the other independent variable without affecting it. A bidirectional outcome occurs when the impact is two-way directional while the outcome is non directional if there exists no obvious towards the influence travelling from a variable to another variable. With this in mind, the deciding factor is accepting the H0 when the value of the probability is higher than 5 % and rejecting it when the value of the probability becomes less than 5%.

It is clearly observed from table 9 that green finance GF and EPS and environmental technical innovation ETI and economic growth GDP possess a unidirectional relationship. There is none directional bond between industrial structure INDS and economic growth GDP and environmental policy stringency EPS and environmental technical innovation ETI. A bidirectional interconnection exists between green finance GF and load capacity factor LCF (a proxy of environmental quality), environmental policy stringency EPS and load capacity factor LCF, environmental technical innovation ETI and load capacity factor LCF, economic growth GDP and load capacity factor LCF, industrial structure INDS and load capacity factor LCF, environmental technical innovation ETI and industrial structure INDS, economic growth GDP and environmental policy stringency EPS, green finance GF and industrial structure INDS, green finance GF and economic growth GDP and green finance GF and environmental technical innovation ETI.

**Table 9 Pairwise Granger Causality Tests**

| Null Hypothesis: | F-Statistic | Prob. |
|---|---|---|
| LGF does not Granger Cause LCF | 1.162 | 0.315 |
| LCF does not Granger Cause LGF | 0.508 | 0.602 |
| LEPS does not Granger Cause LCF | 0.209 | 0.812 |
| LCF does not Granger Cause LEPS | 0.750 | 0.474 |
| LETI does not Granger Cause LCF | 0.243 | 0.784 |
| LCF does not Granger Cause LETI | 0.292 | 0.747 |
| LGDP does not Granger Cause LCF | 0.896 | 0.410 |

| | | |
|---|---|---|
| LCF does not Granger Cause LGDP | 0.215 | 0.807 |
| LINDS does not Granger Cause LCF | 0.276 | 0.759 |
| LCF does not Granger Cause LINDS | 0.932 | 0.395 |
| LEPS does not Granger Cause LGF | 5.197 | 0.006 |
| LGF does not Granger Cause LEPS | 1.923 | 0.148 |
| LETI does not Granger Cause LGF | 2.743 | 0.066 |
| LGF does not Granger Cause LETI | 0.033 | 0.968 |
| LGDP does not Granger Cause LGF | 1.537 | 0.217 |
| LGF does not Granger Cause LGDP | 0.737 | 0.480 |
| LINDS does not Granger Cause LGF | 0.456 | 0.634 |
| LGF does not Granger Cause LINDS | 0.154 | 0.857 |
| LETI does not Granger Cause LEPS | 3.988 | 0.020 |
| LEPS does not Granger Cause LETI | 4.617 | 0.011 |
| LGDP does not Granger Cause LEPS | 0.778 | 0.460 |
| LEPS does not Granger Cause LGDP | 0.472 | 0.624 |
| LINDS does not Granger Cause LEPS | 2.035 | 0.133 |
| LEPS does not Granger Cause LINDS | 0.019 | 0.981 |
| LGDP does not Granger Cause LETI | 0.814 | 0.444 |
| LETI does not Granger Cause LGDP | 4.087 | 0.018 |
| LINDS does not Granger Cause LETI | 2.295 | 0.103 |
| LETI does not Granger Cause LINDS | 0.030 | 0.970 |
| LINDS does not Granger Cause LGDP | 3.367 | 0.036 |
| LGDP does not Granger Cause LINDS | 8.101 | 0.000 |

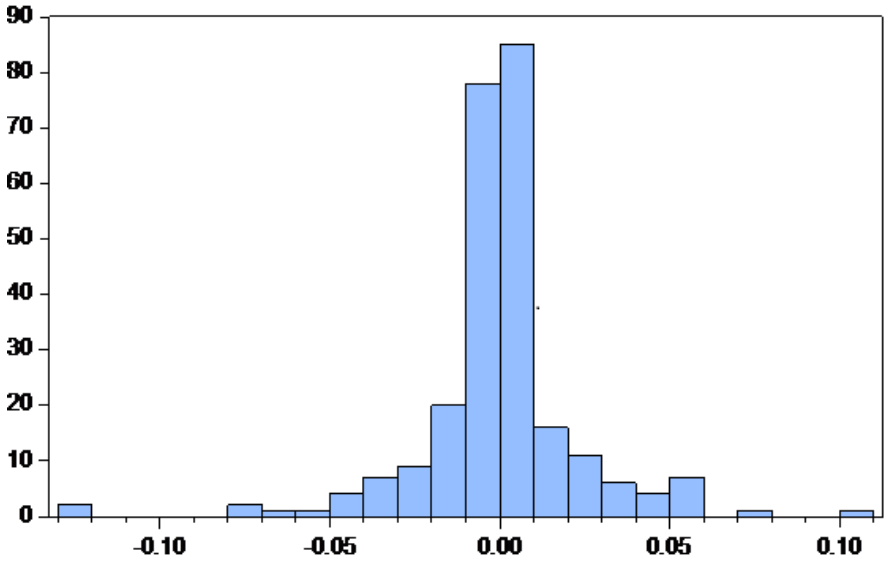
**4.8 Normality test**

In determining whether there is normal distribution of the residuals when the mean is zero and a fixed variance, the study employs normality examination using the jaque-Bera estimation. This aids in knowing if the concerned data is got from normally dispersed population. The hypotheses are given below:

HO: The residuals are distributed normally.

H1: HO is not true**.**

The deciding factor is that when the value of probability of jaque- Bera falls below 5%, it means that there exists normal residual distribution and if the value of probability surpasses 5%, there exists no normal residual distribution. On the basis of the aforementioned deciding factor, as figure 4 depicts, HO which divulges that the residuals are distributed normally is accepted and the H1 which is in opposition to HO is henceforth rejected. Hence, as divulged by this discovery, it is concluded that the residuals are dispersed normally as jaque-Bera estimations depict.




| Series: Residuals | |
|---|---|
| Sample 2000 2018 | |
| Observations 255 | |
| Mean | 5.48e-16 |
| Median | 0.000340 |
| Maximum | 0.100636 |
| Minimum | -0.123652 |
| Std. Dev. | 0.023617 |
| Skewness | -0.736939 |
| Kurtosis | 10.28935 |
| Jarque-Bera | 587.6362 |
| Probability | 0.000000 |

**Note, Source: author' finding**

**Figure 4 Normality test**

# CHAPTER V

## Conclusion and policy recommendation

### 5.2 Introduction

The investigation examines the linkage between green finance, environmental technical innovation, environmental policy stringency, economic growth, industrial structure and environmental quality in 15 OECD economies between 2000 and 2018. The investigation employs econometric techniques in data analysis to examine the linkage between the variables. The econometric techniques employed in this investigation comprises CADF and CIPS second generation unit root test introduced by Pesaran (2007) in checking for stationarity of the parameters utilized in the examination. In checking for the issue of slope heterogeneity associated with the data, the study uses Pesaran and Yamagata (2008) and Westerlund and Blomquist (2013) slope heterogeneity tests. In addition, the study also employs the Johansen Fisher and Westerlund (2008) cointegration tests to explore the long-run association between the variables under the investigation. The study ascertains the short-run and long run co-efficient utilizing the panel ARDL technique. Finally, Pairwise Granger causality test is used to examine the causation bond between the parameters.

### 5.3 Summary of the conclusion

The discoveries of CIPS and CADF unit root tests confirm that LCF and GDP are stationary at first difference. However, the outcomes confirm that green finance, environmental technical innovation, environmental policy stringency and industrial structure gain stationarity at level for both CIPS and CADF methods. The study' empirical findings confirm the issue of slope heterogeneity in utilized data. In addition, the estimations of the cointegration tests reveal the long run relationship of LCF with green finance, environmental technical innovation, environmental policy stringency, economic growth and industrial structure. Furthermore, as confirmed by the empirical results of PARDL, green finance enhances the environmental quality of the OECD nations in the long-run. From the findings however, the short- run co-efficient is also positive but statistically insignificant. This result confirms that the effect of green finance on the environment is not immediate. In addition, the outcomes reveal that environmental

technical innovation boost environmental quality in the long-run. The short-run discoveries however depict the negative influence of environmental technical innovation on environmental quality. This confirms that innovation at first causes a decay in the quality of environment and thereafter boosts the quality of the environment after a particular degree of innovation. In contrast, the outcomes of the PARDL reveal that economic growth negatively affects environmental quality in both long-run and short-run but the short-run effect is however insignificant. This empirical outcome does not authenticate the inverted-U shaped correlation between income and ecological quality in the OECD economies. It is confirmed from the results that industrial structure negatively impacts the environmental quality. Precisely, a surge in industrial structure leads to the reduction in the quality of the environment. Surprisingly, the analysis depicts that environmental policy stringency negatively influences environmental quality. Moreover, the Pairwise Granger causality test results reveal that there exists a unidirectional relationship between green finance and environmental policy stringency and environmental technical innovation and economic growth. A none directional linkage exists between industrial structure and economic growth and environmental technical innovation and environmental policy stringency. The findings also confirm that there is a bidirectional interconnection between green finance and LCF ( a proxy of environmental quality), environmental policy stringency and LCF, environmental technical innovation and LCF, economic growth and LCF, industrial structure and LCF, environmental technical innovation and industrial structure, economic growth and environmental policy stringency, green finance and industrial structure, green finance and economic growth and green finance and environmental technical innovation.

### 5.4 Recommendation and policy inferences

Considering these aforementioned discoveries, the investigation suggests the following policy inferences:

Firstly, the outcomes depict that green finance significantly enhances the environmental quality of the OECD economies. This is a justification of the immense contribution of green finance in boosting the environmental quality of the OECD nation. As a result of this positively significant influence of green finance on environmental quality in OECD,

the governments should carry on in undertaking suitable green finance initiatives such as issuing green bonds to constantly surge the environmental quality. In addition to the efforts of the governments, the privately owned financial organizations should actively participate in fostering green financing. In motivating the private sector's contribution, the governments should offer some incentives like corporation tax breaks to private organizations that enhance and deliver products of green investments.

Secondly, Environmental technical innovation emerges as a crucial tool in boosting environmental quality as revealed by the results. The long-run results of PARDL indicate that a 1% rise in environmental technical innovation causes a 0.097 % surge in OECD's environmental quality. This gives a useful vision to the OECD governments. The governments and private sectors may allot a substantial funding for research and development initiatives in environmental related innovations. In addition, companies making investments in environmentally friendly technologies may be eligible for tax exemptions and incentives. Moreover, enhancing technology commerce between these nations is useful for increasing the technological spillovers amongst pertinent nations. Certain environmentally friendly and energy-efficient technical innovations should be developed, displayed, and promoted for improvement. Authorities could, for instance, support businesses to set up solid mechanisms to raise informational volumes and boost operational effectiveness.

Thirdly, the outcomes indicate that both economic growth and industrial structure negatively affect environmental quality in OECD. This can be in connection to excessive utilization of non-renewable energy in production. The consumption of renewable energy is the remedy for this problem. The governments may encourage the utilization of renewable energy since the consumption of renewable will be very crucial in promoting both economic growth as well as enhancement in environmental quality. Furthermore, the OECD policy makers need to phase out traditional, high-emission sunset industry sectors, develop pertinent initiatives to support the growing sunrise industry sectors, allocate enough resources for science-based Research & development activities, as well as establish an excellent basis for ensuing ecologically sound structural industrial change.

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