Master's Thesis of International Studies

Effects of Economic Development and Trade on the Environment

- Costa Rica and South Korea Case Study -

경제발전과 국제무역이 환경에 주는 영향 분석:
코스타리카와 한국의 사례

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Abstract

With this thesis, the goal is to incite change towards a green economy through the analysis of a more comprehensive metric of environmental quality and its relationship with economic development and trade. Sustainable Development is a newer concept of development that comes to challenge the traditional understanding of growth and welfare, and for that reason precisely is why we as a society should also push for a transformation not only in the international economic structure but also in every world-citizen's mind.

Education is the key to many of the doors for development; so with that intent, instead of utilizing environmental measures focused on deterioration like CO2, this study utilizes the Environmental Performance Index (EPI). Which can be a more comprehensive and complex measure of environmental quality; for that reason, we will run a simple linear regression with panel data from about 153 countries for the 1990-2020 period.

For our model, along with a more well-rounded environmental measure; due to the sustainable development concept being more complex than conventional economic growth, we will also use social indicators like education and population density. The reasoning behind this logic is that in order to deepen our understanding of the impact of human growth and development on our natural capital, economic growth measures are simply too intricate and insufficient.

Moreover, we will also analyze how two particular economies like Costa Rica: a country known to have made considerable efforts to develop their economy in a more sustainable way, and South Korea: an economic development miracle country have impacted their natural capital. We will examine both countries' current state as well as some of their historical trends in pertinent environmental measures, given their chosen development strategies.

The analysis of both countries could give us a better idea of how environmental factors can interact with economic policy decisions and which ones could be a better path to follow in the future. However, it is important to remember that international efforts like the ones in 2015 with the Paris Agreement have influenced countries to bigger compromises regarding the climate change crisis, as well as periodic evaluations; so a dummy variable for 2015 and posterior years will be added to our model with the intention of assessing if there has been any statistically significant change since then.

Keyword: Environment, Development, Trade, Sustainability, Green Economy.

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1. Introduction

1.1. Study Background

The conservation and preservation of resources as well as the environment all together, have been some undoubtedly popularized topics lately; given the evident challenges faced in the last couple of decades due to climate change and over-all deterioration of the planet, the general response we have seen as a society can be even considered sluggish and unsuitable by some. For that reason, in recent decades parts of the civil society have organized themselves and demanded a more proactive approach to the issue from their governments and bigger corporations.

Similarly, some international organizations have tried to push forward and create binding agreements that promote a greener and more sustainable growth. Nevertheless, the major accomplishment in the international arena so far will be the 2015 Paris Agreement (UNFCCC, n.d.b)[1], and even though the United Nations (UN) started taking initiatives against climate change in 1988 (Stern, Bowen, & Whalley, 2014) sadly the planet keeps on heating up. Causing different challenges for the entire world population, especially those in vulnerable positions.

Thus far, one of the main issues discussed while trying to tackle the environmental crisis, is that emerging economies and island states tend to be more prone to vulnerabilities (Abeygunawardena, et al., 2009), but the scope of what they can do is minuscule in comparison to some of the bigger polluting countries like China, the US, and India (Global Carbon Project, 2020). That is why international initiatives like the Paris Agreement brought some kind of hope to the concerned global citizens; in it, 196 countries promised to unite efforts with the end goal of keeping global warming below 2°C or preferably under 1.5°C pre-industrial

[1] United Nations Framework Convention on Climate Change.

levels, along with the minimization of carbon emissions to achieve neutrality by 2050 (UNFCCC, n.d.b).

Yet, since the main key of the agreement are the Nationally Determined Contributions (NDCs) and some countries might be less proactive than others, the imperative of a shift to circular economy and sustainability becomes even more resounding. Hence, 2015 is a crucial year when trying to analyze the global environmental protection efforts since several attempts on sustainable development where also set this year (i.e. The Sustainable Development Goals) (UNDP, n.d.), triggering a myriad of endeavors not only at state level but also within the civil society and the business world.

Although, some of these initiatives are not necessarily sustainable; sadly some governments policies have ended promoting green consumerism instead of encouraging sustaianble consumption (Akenji, 2014, p. 13); decreasing the expected positive impacts on the environment; since consumers have not really change their consumptions habits to a more sustainable lifestyle; creating an illusion of progress (Akenji, 2014). We might need more evidence guiding to a new conceptualization of development; one that encompasses the newly developed necessities of the world and brings a new lifestyle and ideology towards the conventional social imaginary.

1.2. Relevant Concepts

When dealing with the economy and its relationship with the environment, some concepts might come to mind as crucial notions while trying to reach a sustainable strategy of development. However, there are some ideas that can get easily confused, and some might even think about them as interchangeable. But to further understand the topic, and to also comprehend the reason why certain variables will be chosen as measures for our designed model of study, it is an

imperative to be able to distinguish these terms and what makes them important in the context of the present study as well as sustainability in general.

Even though it is not a difficult task per se, it can be intricate; fortunately, in 2016 there was a noteworthy article published at the Journal of Cleaner Production that tackles green economy and its related concepts (Antikainen, et al., 2016). For that reason, it will work as our main source of information for the establishing of definitions in this study.

1.2.1. Bioeconomy

This is a concept that has been under debate within different spheres; specially practical use at international and governmental level in contrast with bioeconomic theory nevertheless for the purpose of this study, we will use an OECD definition from 2009 which denominated bioeconomy as all the economic activities that use biological goods and methods related to development, consequently it also depend on biotechnology advances to modify living an non-living matter in order to make it more sustainable whatever the nature of its output: goods, services or knowledge (Antikainen, et al., 2016, p. 366).

1.2.2. Circular Economy

Following The Ellen McArthur Foundation definition, circular economy can be understood as type of industrial economy which tries to be restorative and mirror nature by keenly omptimizing and upgrading they way it functions (Antikainen, et al., 2016, p. 365). Nevertheless, something important to keep in mind is that according to Lifset and Graedel (2002):

Circular economy along with industrial ecology tries to go past firm level organization of waste hierarchy and resource efficiency; it highlights the spectrum of action by expanding into more holistic approaches and carrying out a more universal level of cooperation and designing within the whole economy resource flow; making it circular not only within the firm but taking it regional and global,

through a macroeconomic perspective approach. (Antikainen, et al., 2016, p. 365).

1.2.3. Cleaner Production

In the 1990's UNEP conceptualized cleaner production essentially as a constant approach and application of a well-rounded environmental strategy at the time of production along with the accomplishment of processes and provision of services with the intent to reduce damages to the environment and humans in consort with resource efficiency (Antikainen, et al., 2016, p.364).

1.2.4. Dematerialization

Dematerialization possesses a key part in the required shift to find the desired balance in the ecological economics, and it focuses on the reduction of material and energy use per unit of service output; by accomplishing this, the human linear systems of production can see a decrease in volume as well as toxicity and contamination; closing cycles of materials and energy (Antikainen, et al., 2016, p. 364). Meaning, the reduction or decline of material or energy used in the process of completing an economic activity with the same output as before.

1.2.5. Ecological Economics

Ecological Economics differs from environmental economics in the sense that the economy is considered a subsystem from nature, the later directly affecting the limit of growth possible for the economy, for that reason it will constrain any potential operationalization of those resources to limits of the planet; therefore, harmony and self-reliance between the systems and the beings in it should be maintained. In order to measure the symbiotic relationship between the economy and the availability of resources, as well as the health of nature, in this field of economic there will be physical or ecologic indicators that might reflect the state of the needed harmony (Antikainen, et al., 2016, p. 364).

1.2.6. Environmental Economics

Following Antikainen et al., environmental economics fundamentally seeks to

correctly value the natural capital using different economic methods, pointing out inefficiencies in the use of the resources and the constant undervaluation of nature. From this principle different tools, hypothesis and methods of analysis might be born; and the categorization of different effects and cost will be analyzed. However the main issue is that the value of nature or natural resources have been historically overlooked, causing most of the challenges we face today; and the faster we manage to set the right price which reflects the external environmental costs, sustainable use of natural resources could finally come to be (Antikainen, et al., 2016, p.364).

1.2.7. Green Economy, Green Growth & Green Finance

When it come to the definition of green economy, the lines get blurry in comparison to other popular terms like green growth, however they are slightly different. Following Antikainen et al., green economy was officially coined by the UN at the 2012 Conference on Sustainable Development (Rio+20); although, following Le Blanc (2011), we have evidence that green economy was firstly introduced in the academic world back in 1989 (as cited in Antikainen, et al., 2016, p. 362). Yet, the conceptualization employed in this study will adhere to the UNEP[2] understanding of green economy, which is thought to improve social equity along with the well-being of not only humans but also of nature, making it posible to minimize risk to the environment and ecological scarcity. Which in a few words can be summarized as a resource-efficient, socially inclusive, low carbon approach to growth; additionally, UNEP stresses the significance of natural capital preservation which are not only natural resources but also ecosystems (Antikainen, et al., 2016, p. 362).

[2] United Nations Environment Programme.

Now, according to an OECD[3] paper back in 2011 green growth focuses on supporting economic growth and development whilst guaranteeing the continuance of our natural assest: resources and environmental services necessary for our well-being (Antikainen, et al., 2016, p.362). They also add that in order to reach such growth investment and innovation will be key, meaning that a green growth strategy should be attractive enough to catalyze new sustainable economic opportunities (Antikainen, et al., 2016, p.362); concurrently, the World Bank sees green growth as efficient qualitative growth in terms of natural resources usage, and a cleaner way of production in the sense that pollution can be minimized along with the damages to the environment, additionally it is resilient because it points out natural hazards and explains them (Antikainen, et al., 2016, p.362).

Regarding green finance there is no specific concept however in the international financing system it has become more and more common the usage of terms like green bonds and green banking. This is why in 2016 the UNEP requested an inquiry paper about the use and concepts of green finance internationally, with the intend to have a better understanding for the G20 Green Finance Study Group (GFSG).

In this paper, several definitions by numerous international financing institutions are listed; yet from all of them one may understand green finance as a strategy or policy set in place to foster investment and development of the economy and its shift to cleaner and more sustainable courses of action; meaning promoting protection of the environment, reductions of emissions, resource efficiency and more in order to uphold a good balance within the natural assets of the planet (Forstater & Zhang, 2016). Something relevant to mention is that there are some similar and almost interchangeable terms with green finance and those

[3] Organization for Economic Co-Operation and Development.

will be climate finance, low-carbon finance and sustainable finance (Forstater & Zhang, 2016).

1.2.8. Industrial Ecology

Industrial Ecology can be understood as a research field that combines sustainability, the environment, and the economy with the intend to optimize the use of energy and the minimization of waste generation; which also inspires other concepts like circular economy; nevertheless the core of industrial ecology is the use of methods like biological analogies, systems perspectives, technological changes and dematerialization (Antikainen, et al., 2016, p. 365).

1.2.9. Life Cycle (LCA), Material Flow Analysis(MFA) & Cost Benefit Analysis (CBA)

Life cycle assessment can be also known simply as life assessment or ecobalance, and cradle-to-cradle analysis; this is a technique that is used to evaluate the impact on the environment caused by the cycles or stages of a product's life (Krishna, Manickman, Davergave, & Shah, 2017, p. 57). Now, material flow analysis is similar; MFA is also essential to industrial ecology and it could be described as a systematic assessment of the stock of resources within a system at a determined space and time, basically a systematic accounting method of resources (Kaufman, 2012).

This assesment of stock can be essentially conceived as an accounting system of physical unites that quantifies inputs and outputs of the processes analyzed and can be applied at different levels: susbstances, materials or products and these at the same time can be contained within firms, sectors or regions (Antikainen, et al., 2016 p. 366). On the other hand, cost benefit analysis can be seen more as a tool that helps to asses the welfare of an investment or project and its effects; therefore, CBA tries to measure both producers and consumers surplus (Antikainen, et al., 2016 p. 366). As a 2011 paper from the UNEP said CBA can be a comprhensive

way of comparing different dimensions of green economy strategies like the environment, the economy as well as social dimensions (Antikainen, et al., 2016 p. 366), making it a considerably significant tool going forward on our green growth path.

1.2.10. Nature-Based Solutions & Green Infrastructure

Nature-based solutions concept is relatively new and trendy in the environmental and sustainability policies; it essentially aims investments to the natural capital or natural assets of an economy in order to improve their ecosystem; it should be a multifaceted approach that fulfills the principles of sustainable development that not only preserves our natural assets but also increments them (Antikainen, et al., 2016, p. 366). Due to its holistic approach a new concept emerged from it: green infrastructure (GI), it is fundamentally a strategy that uses nature-based solutions to fix a problem, for example there is a EU[4] GI plan which consists in several green areas throughout the city not only to fix water absorption issues but also to improve the air quality as well as providing shade during the heat season, with an added value of sightseeing given the natural vibe of the place within the city(Antikainen, et al., 2016, p. 366).

1.2.11. Product-Service System(PSS)

In the 1990's the concept of PSS was born in Europe, the idea was to combine goods and services to fulfill the needs of the consumers all together; in contrast to product-based systems, PSS tries to follow the line of dematerialization and extend the the functionality of a product's life and derive services from there that can be fulfilled by producers and suppliers (Antikainen, et al., 2016p. 367).

1.2.12. Resource Efficiency

Resource efficiency tries to improve the way we use our natural resources in

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[4] European Union.

the value-chain of production (especially from a firm perspective), aiming at eco-designing as well as the general efforts towards the reduction of emissions and technological innovations waste generation. Being coherent with the environmental economic's belief about the relvant role of continuous improvements in the transition towards sustainability and its significance for the rate of substition of natural capital into human capital or man-made goods (Antikainen, et al., 2016, p.365).

1.2.13. Sustainable Development

While looking for the concept of sustainability in the international organizations, one can see that the term is fundamentally interchangeable with Sustainable Development. Several Supranational Organizations will have their own definition of Sustainable Development; however, according to Antikainen et al., the term was formally adopted in the 1992 UN Earth Summit in Rio de Janeiro where as stated in the Brundtland Report, sustainable development can be understood as a type of development that meets its current needs without compromising the future ones or their ability to do so (Antikainen, et al., 2016, p.361).

1.2.14. Waste Hierarchy

Waste hierarchy is essentially the reuse, repair, recover and recycle tool; which at the same time can be also tought of as prevention, recycle, recovery and disposal. This is a ranking instrument for the waste management processes, and they are imperative to reach a good harmony with nature while producing and consuming goods; they help with the advancement of resource efficiency while also minimizing the need of materials and trying to implement a more circular economy approach by closing material flows (Antikainen, et al., 2016, p.365).

1.3. Purpose of Research

Due to the increasing relevance of the topic; and given the specific compromises adopted internationally in 2015, it would be interesting to assess the effects of economic development and trade on the environment. Although, since the compromises were taken not so long ago and some of the NDCs from some countries are still just in initial stages, it would be better to review the relationship among these variables from the last decades.

The research in environmental issues, development, and the economy per se are a trending topic in the international community; the necessity for a change in the traditional structure of our economy is critical if we want to maintain a habitable planet. Nonetheless, there is still a lot of debate on which is the best direction to follow for reaching the desirable levels of development in harmony with nature; specially for those more vulnerable countries that have less resources and more issues to deal with than purely nature preservation alone.

This study does not provide a specific answer to this debate; however, it intends to present evidence of the relationship between the environment quality and some key development indicators. The need to focus on a better system where there can be congruence between the resources of this planet and the desired development level for all, in conjunction with a good lifestyle that makes our consumption more resource efficient, urban planning that inclines more towards green infrastructure strategies, and an economy that is more sustainable in a circular economy model is simply impossible to ignore or put off anymore.

Sustainability in the context of green economy does not only reflect the relationship between economic development and nature but it also makes reference to social equality. As a result, the international efforts on sustainable development are very heterogeneous and try to also minimize the vulnerabilities of several

minorities or historically marginalized groups.

Consequently, it is necessary to evolve and transform our way of thinking; we need to comprehend development as a wider term. In this day and age, the needs and injustices lived by many are finally being heard more and more; the traditional approach to development needs to expand and contemplate more that economical growth along with some social indicators.

Observing the current challenges along with the fast deterioration of our ecosystems and the continuous environmental issues to which we have had to adapt due to the decline of nature, should have made clear to all of us that we should follow the teachings of environmental economics and start giving our natural capital the value it deserves; and that the complete transformation of our mostly linear economy to a circular economy is a must if we intend to keep surviving as a species. Even though, not everyone can be an expert on this sort of issues, one person can incite change, and this is one of the main inspirations behind this research.

The need of more evidence on how changing our ways can actually help minimize emissions and stop climate change is on the core of this study, and with news about the COP26[5] coming up whenever one connects to any news outlet there are more and more news about the insufficient efforts from the governments. Although in recent decades there is an affluent number of research tackling down ways to help slow down or stop climate change, the truth is some governments, firms and people around the world have not given the topic the sense of urgency it requires. In the international relations arena, the research focused on environment has also been increasing; however, in the present study we chose two particular economies and reviewed their current environmental quality and growth level,

[5] The United Nations 26th Climate Change Conference of Parties.

given their particularities and chosen development strategies.

1.3.1. About Chosen Countries

The chosen countries for this study have a reason for being selected, and with the intend to further understand this selection, it will be pertinent to know some of their historical background as well as notable aspects of their models of development and current state of these economies. Therefore, in the next subsections we will briefly summarize some of the peculiarities these two countries possess and have consequently made them be chosen for this study.

1.3.1.1. Costa Rica

Costa Rica is a country that internationally has had a reputation of being eco-friendly and some of the efforts that have built this reputation have also made them the winner of the recent Earthshot Prize in the category of Protect and Restore Nature Prize this past October 17th (The Earthshot Prize, 2021). Costa Rica has worked towards a stronger strategy of sustainable development for some time now, however it was not always the case. Back in the 1990's the country experience a shift on their environmental legislation due to the international influence from the environmentally focused global initiatives of the decade, like the Rio Declaration on Environment and Development, the Kyoto Protocol, and Agenda 21 to name a few; which lead to a creation of several institutions, programs and more policies pro-conservation and protection of nature within the country (FONAFIFO, 2018).

One of the programs developed under this framework was the Payment of Environmental Services (PSA)[6], due to this program Costa Rica was nominated and awarded the Earthshot Prize (The Earthshot Prize, 2021). The PSA financially recognizes the services that forests and forest plantations are providing the economy and the country through the environmental services stablished by law:

[6] Pagos por Servicios Ambientales in spanish.

GreenHouse Gas (GHG) mitigation, biodiversity protection, water protection and scenic beauty protection (FONAFIFO, 2018) (ONF, 2020).

Endeavors like this program are not the only reason why the country is known for its greener conscience, but also aspects like their electric grid. The country has run on more than 98.5% of renewable energy since 2014 (Presidencia de la República de Costa Rica, 2019), trend that has been maintained until the latest reports from CENCE[7], their National Center of Energy Control (CENCE, 2020).

Additionally, since the Paris Agreement the country strengthen their climate action strategy and drafted their NDCs focusing on further action on low emissions resiliency, mitigation, and adaptation (Government of Costa Rica, 2015).

But it has also developed a series of policies and programs to expand their take on climate change and global warming[8]. Some of the most crucial policies are the National Decarbonization Plan where the country's strategy to reach carbon neutrality is detailed (Government of Costa Rica, 2019), along with the National Adaptation Policy in which the government intends to take a green infrastructure approach to the vulnerabilities the country is having and could have due to climate change (Gobierno de la República de Costa Rica, 2018). Nevertheless, it is important to know that even though Costa Rica managed to enter the OECD as it 38th member earlier this year (OECD, 2021b), there are still many areas to improve (OECD, 2020a), especially macroeconomic policies, inequality, productivity and the transport sector (OECD, 2020c).

1.3.1.2. South Korea

The second chosen country is South Korea, this nation has experienced an economic development "miracle", going from a developing country to a developed

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[7] Centro Nacional de Control de Energía in spanish.
[8] See Annex 1 for a CAT graph on Costa Rica's environmental policies overview.

country that grew rapidly and sustained at 6% annually during six decades (Jeong, 2018). In order to accomplish this sort of miracle the economy underwent several reforms and processes that have brought them to the level they are enjoying right now.

To reach this level of development and growth Korea also had to decide within their resources what were the most valuable factors to protect and which ones to exploit. After the war the country was in a very concerning state, mountains were basically bear, exacerbating issues like erosion and flooding, they also had to overcome the heavy dependance the economy had to fuel wood, which was one of the main sources of income for their people at the time(Lee & Youn). Nonetheless Korea managed to become one of the biggest economies in the world (The Economist, 2018) which is why it is going to be used an exemplary country in terms of economic development and trade.

Countries are used to devaluating their natural capital, which sadly is not the only issue. On top of the devaluation, natural capital is usually the first factor to go when taking priorities in the drafting of developing strategies; but with the escalation and proliferation of challenges caused by climate changes, governments have had to vastly try and adopt greener policies; the Paris Agreement is a milestone in this arena, and it has influenced a lot of changes.

However, South Korea's NDCs may not be as radical as one could expect from a nation that has been able to drastically overcome substantial hardships. Some environmentalists groups even described Korea's NDC's as "highly insufficient"[9] (CAT, 2021); nonetheless something positive for this nation is that it has been in the top 10 countries of the Global Innovation Index for a couple of years now (WIPO, 2021), which is a characteristic that might help introduce and

[9] See Annex 2 for a CAT graph on Korea's environmental policies ovierview.

generate new technologies to reduce emissions and help manage climate change and its challenges better.

Nevertheless, at the same moment of writing this study, the COP26 is taking place in Glasgow; here the president Moon Jae-In pledged to upgrade Korea's NDC by setting stronger emissions reductions targets (Kim, 2021), which could help the country strengthen their plan of action against climate change. Korea is not exempted from the current challenges caused by climate change; according to the widespread air quality measuring site IQAir, for the year 2020 Korea placed 41st out of 106 countries in their AQI Country Ranking of worst air quality during the year, and in the World Capital City Ranking Seoul was placed 33th (IQAir, 2020), thus the undertaking of this issue could also bring observable benefits for the country.

1.4. Preliminary Data

With the end of better comprehending the predicament of climate change, sustainability, and development it will be vital to examine several different factors of an economy as well as environmental health and vitality. However, in this section we will review the current state of the main variables of our model: EPI, Income, Trade, Scholarity and Demography[10], for both of the countries we are studying.

1.4.1. EPI

When it comes to the Environmental Performance Index it is important to know that the data availability is rather scarce; for that reason, not only will the preliminary data be constrained by it, but also our future regression analysis. Even so, this index provides a more holistic way of evaluating environmental quality, the EPI uses 32 performance indicators for 11 issue categories that deliver a *data-*

[10] In our base model the variable pertinent to demography would be population density.

driven summary about the state of sustainability globally; in which 180 countries are ranked on environmental health as well as ecosystem vitality (Wendling, et al., 2020). The scoring system basically works by rating each one of the indicators (which have a weight[11] on the final score), the higher the rate the better the position.

Additionally, it is important to mention that while reviewing the archives of the EPI and the latest releases, the index varies somewhat in the indicators and categories classifications throughout the years. Still, the core of the index, which are environmental health and ecosystem vitality remain the same (Hsu, et al., 2016)[12]. Now, with the intend to analyze as much data as possible we will call historical trends those results gotten from the EPI archives, while rankings from the 2020 report will be shown separately. In the Annex 3 and 4 respectively there will be a graph with the countries that have had the highest and the lowest score historically and then the same for the 2020 data.

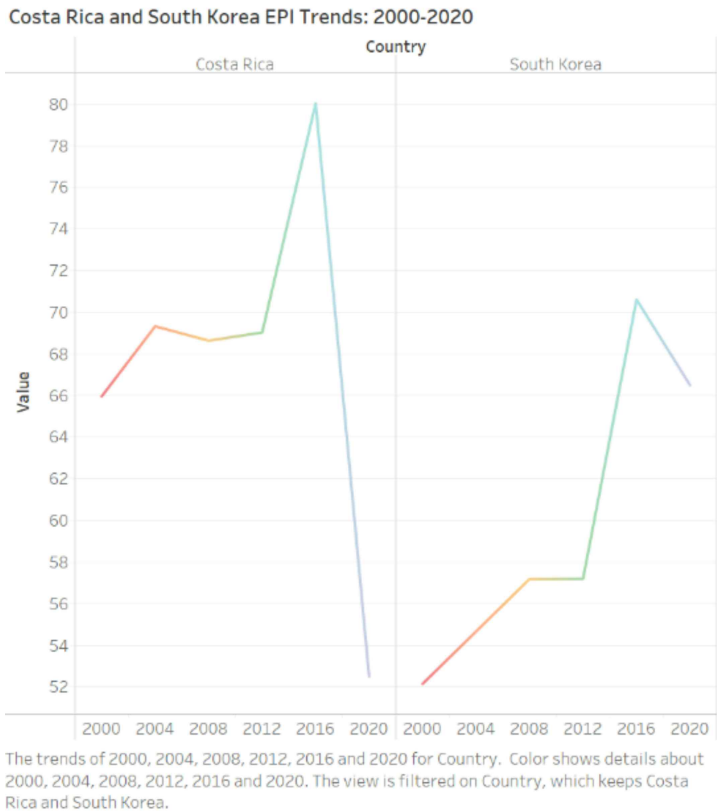
For the historical trend the top three countries will be Finland, Iceland and Sweden; countries that are members of the OECD, which makes it more comparable to the counties under study given that both Costa Rica and Korea are members. Interestingly enough, for most countries worldwide there is a similar trend of increasing their EPI score to a top in 2016 which tends to fall down abruptly afterwards; issue that would contradict our initial hypothesis that the recent international efforts could have had a positive influence in the protection of the environment, or it could also simply be evidencing what experts have been mentioning for some time now (and specially resounding in the current COP26), that our efforts are not enough and thinking that our nature, forestry, and oceans

[11] The weights of each indicator are better depicted in Annex 3.

[12] In the Annex 3 and 4 will be a descriptive figure of both EPI 2020 and EPI 2016 framework, where the indicator and categories classification can be better visualized.

alone will be able to absorb the emissions, and fortify our ecosystems and nature is simply impossible, we keep on damaging nature faster than our reparations (Martin et al., 2021).

Figure 1. Costa Rica and South Korea EPI Trends



Furthermore, if we analyze the OECD countries it can be surprising to find out that for the 2020 EPI Costa Rica had such a low score (52.5-52nd place) that it is part of the three countries with the lowest ranking within the OECD; for that year Turkey being the worst also historically obtained a 42.6 gaining the world ranking of 99th place; while Mexico ranked 51st with a score of 52.6. Meanwhile, in 2020 South Korea got a score of 66.5 obtaining the 28th place.

As seen in the graph above Korea started the millennium in a worse position than Costa Rica. Yet, the 2020 drop is abysmal taking back this Latin country to a

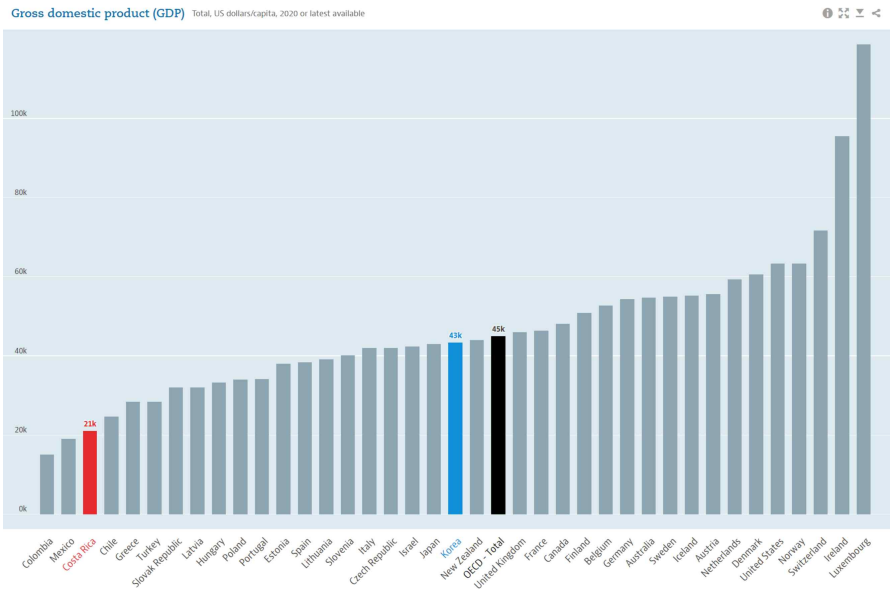
score way lower that the one registered in the early 2000's, which very similar to that one of Korea's in the beginning of the millennium.

Costa Rica reached a peak in 2016 with a score of 80.03 where they reached place 42nd while Korea was in place 80th with a score of 70.61, also the peak score for this economy (Hsu, et al., 2016). The reason of this declining in the EPI score is worldwide and unclear, though given the recent events within the two timeframes the only major issue at a global level could have been COVID-19. If this were true, then the pandemic could have put some sort of pressure in the resources, which then ended up affecting the score; nonetheless, these are merely assumptions and there is no evidence to support this claim.

1.4.2. Income Stats

As previously mentioned, even though these both countries are members of the OECD in most economic indicators Korea is better off than Costa Rica; nevertheless in issues like income inequality and relative poverty both of these countries are in the bottom half of the OECD members (OECD, 2020b) (OECD, 2020f). In terms of Gross Domestic Product (GDP), for the year 2020 both of the countries under study are below the OECD baseline of $44,964 per capita. Nevertheless, Costa Rica is considerably lower than Korea, the Asian country has $43,319 while the Latin one only has $21,044. Even though, the GDP per capita is the most customary way of capturing economic development it is not a good welfare indicator, so in order to further understand the real state of the countries more variables should be considered.

Figure 2. 2020 OECD GDP per capita[13]



1.4.3. Trade

In regards to trade, the first statistics to review will be the percentage of trade from the GDP. For 2020, in the total trade percentage of the GDP Costa Rica had 59%, from which imports represent 28% while exports correspond to 31% of the GDP. Conversely, in Korea's case the total was 70%, with basically 33% for imports and 36% for export[14]; making both countries to have a positive balance for this year in their international trading.

While reviewing the raw data from the World Development Indicators-WDI used in the present study, it should be mentioned that the trade percentage of the GDP of these countries has been decreasing in the recent years. In Costa Rica's case this decrease is so vast that 2020's percentage is smaller than what it was in 1990; while Korea on the other hand, even though there is a clear decrease, it is

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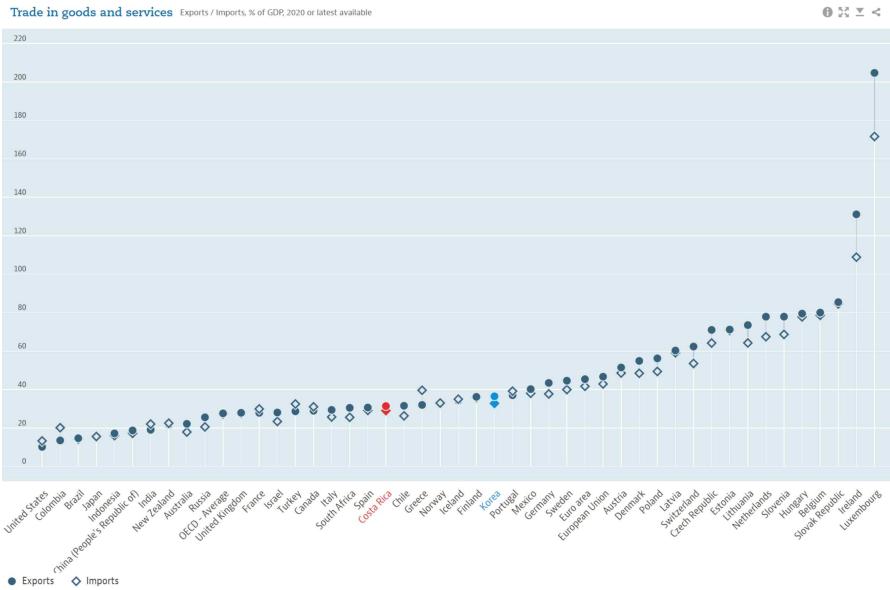
[13] Source: OECD Data website.

[14] Due to rounding the consolidated percentages may not add up at decimals levels; the total trade percentage from the GDP was obtained from the World Development Indicators raw data while the exports and imports come from OECD Data.

still bigger than the 90's.

Figure 3. Trade percentage of the GDP 2020: OECD members[15]



The reason for this decline is unknown or uncertain within the reason of the present study; however for the most recent drop, an assumption one could clearly make is COVID-19. With the pandemic, world trade went through somewhat of a crisis and most countries saw their trade halted due to the emergency situation; nonetheless, it is clear that the bigger drops were earlier: for Costa Rica it was around 2008 while for Korea it was just about 2012.

From those dates the 2008 makes somewhat splash due to the economic crisis that badly hit one of Costa Rica's biggest trade partners: the United States; issue that could have had some influence. Still, for Korea the meaning of the 2012-2016 drop is still undetermined; although a meaningful aspect to mention is that during that time Korea experienced the presidency of the infamous Park Geun-hye which was full of ups and downs to say the least (BBC, 2018).

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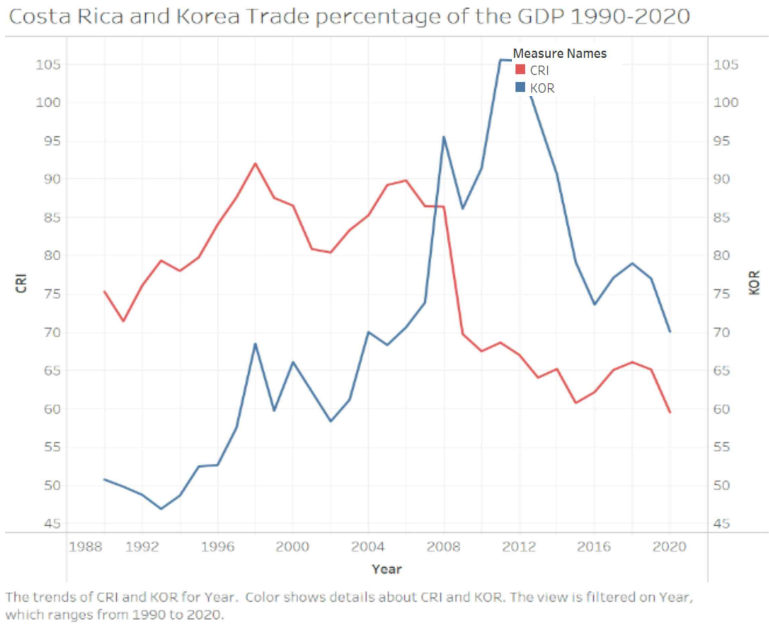
[15] Source: OECD Data Website.

Figure 4. Costa Rica and Korea Trade percentage of the GDP 1990-2000[16]



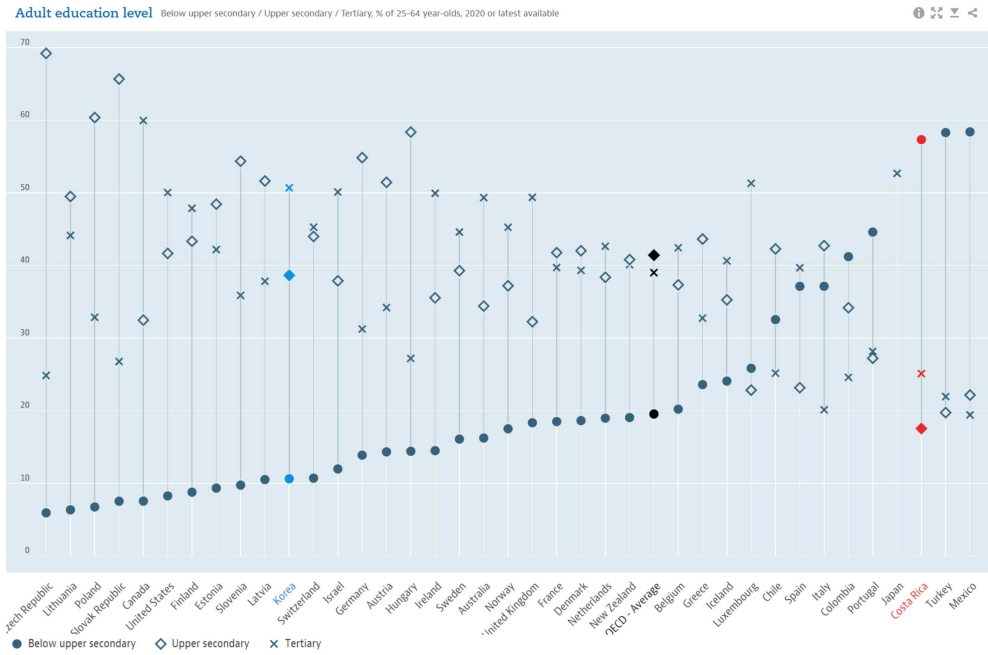
1.4.4. Scholarity

Another common and more accepted indicator for development, which has been added to international measures like the UNDP[17] Human Development Index (HDI), is scholarity or years of schooling; it can provide interest insights about the economy's human capital. Initially when it comes to the education level of the adult population at the "below upper secondary" Costa Rica has 53.7% while Korea only has 10.6%; however this specific measure is not that positive if the economic strategy of the country is required to have highly educated labor force.

Figure 5. OECD countries Adult Education Level

[16] Own preparation with raw data from the WDI database.

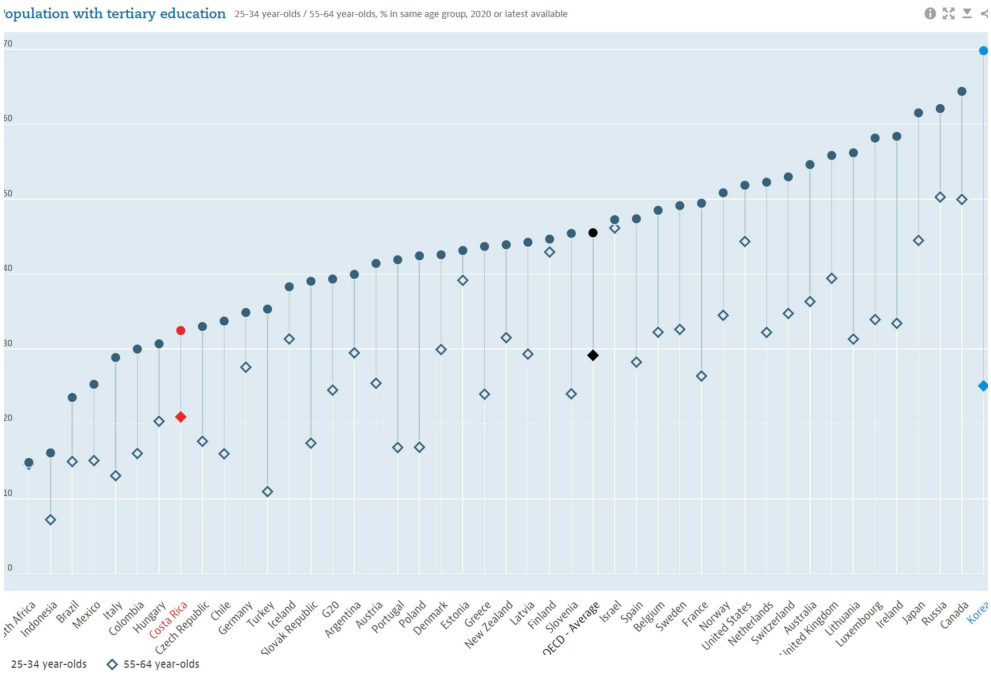
[17] United Nations Development Programme



Even though the country should cater their education supply to best fit their current labor demand it needs to be said that even if there is a considerable amount of population that is educated in comparison to rest of the world, this indicator has left much to wish in the scholarity area. Going further into this education issue, if a country wants to create and innovate not only in general technology but also in greener strategies, population that is highly educated is going to be needed.

If there are more brains, the R&D strategy of the country can also improve; but following the previous graph it is clear the resources needed are not there, for that reason they will be needed to be imported from other countries. If we analyze specifically the percentage of population that has pursued higher education in the OECD countries we will find that Korea is leading the board with almost 70% of its population within the age of 25 -34 years old, while Costa Rica is in the lower half with only above 30% of its population in the same bracket.

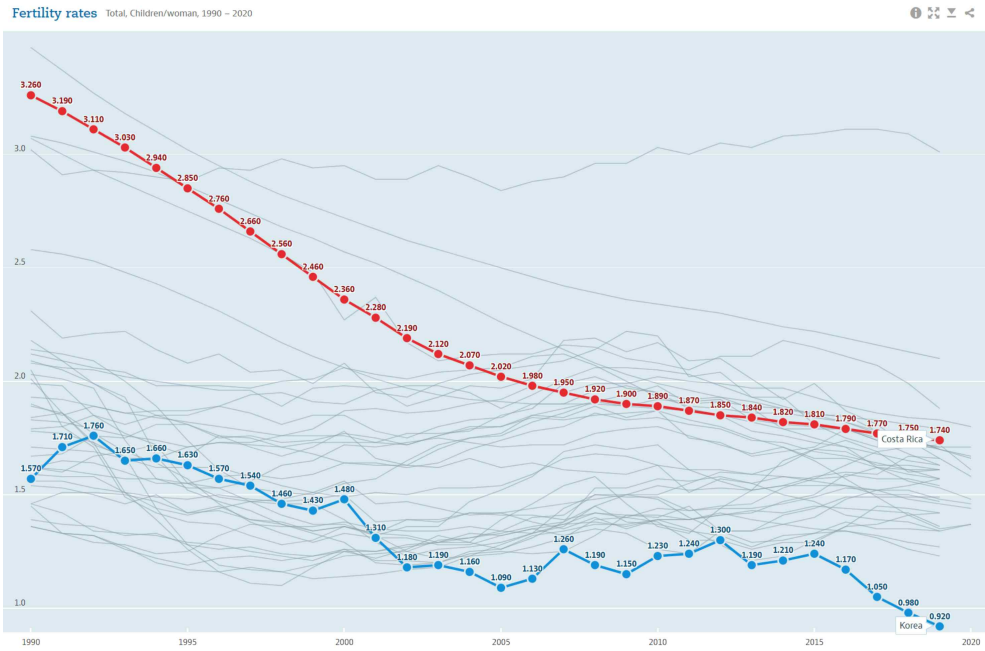
Figure 6. OECD countries Population with Tertiary Education



1.4.5. Demography

When it comes to population aspects expectedly due to its size Costa Rica is quite a small country with only 5 million of people per the last census; while Korea a rather bigger country in comparison has 52 million of people, which compared to the biggest countries in the world is still quite modest (OECD, 2020e). Furthermore as seen in the graph below both countries fertility rates have been experiencing a continuously decreasing trend; in comparison Costa Rica is higher with 1.740 children per women, but Korea's case can be worrisome since the lasts two recorded years have had a fertility rate under 1; which in the future could cause various challenges as an economy that need to take care of an aging population with not enough man power in the labor force.

Figure 7. OECD countries Fertility Rate 1990-2020



Now, while analyzing the demographic aspects of an economy with the intention of also reviewing the environment, the relationship between pollution and population can be significant. Following Borck & Schrauth (2021), Eriksson & Zehaie (2005), and Kim, Chang & Kim (2021) this relationship can be inconclusive and even have opposite results varying on the case; but it certainly is interesting and seemingly somewhat positive. However in that regard, the population density trend for both countries has been simply a steady continuous growing trend, therefore the graph for such performance would not be added.

2. Methodology and Model Specifications

When it comes to the analysis of the potential link or relationship between economic development and environmental quality, the experts in economy have had different points of views and even contradictory finds. However, in these studies the usual way of measuring environmental quality is the volume of carbon

dioxide (CO2) or other Green House Gas (GHG) emissions, but this is only one of the measurable factors that conform nature or the environment; the main existing difference with the present study is that our environment variable in the regression will be measure using an environmental quality index, one that is composed by several sub-indicators which can be majorly categorized in 32 performance indicators (EPI, 2020a). This index is the Environmental Performance Index-EPI, which is calculated by several environmental and policy research centers and institutes from Yale, Columbia University, The McCall MacBain Foundation (EPI, 2020a) (SEDAC, 2021).

2.1. Methodology

With this study, we aim to better understand the relationship among trade, economic development an environmental quality; specially after the recent international efforts to reduce climate change and global warming effects. Therefore, this study makes use of panel data from 1990 to 2020 (in the cases where data is available) of about a 153 countries.

Since the goal is to run a simple linear regression with fixed effects of country and time where the effects of trade and economic development on the environment are evidenced, it was pertinent to take some liberties at the time of constructing the model. Internationally, there is somewhat of a consensus that moving forward into a more sustainable strategy of development also means that the traditional ways of thinking about development needs to change. Denoting that the understanding of development as merely economic development or simply adding some social indicators (like it is the case of the HDI), is just outdated and insufficient in terms of actual welfare.

Table 1. Variable per indicator and source

Variable	*Indicator*	*Source*
Environment	Environmental Performance Index	EPI dataset
Income	GDP per capita (constant 2010 US$)	WDI database
Economy Size	GDP (constant 2010 US$)	WDI database
Trade	Trade percentage of the GDP	WDI database
Density	Density (people per sq. km of land area)	WDI database
Scholarity	Mean Years of Schooling	UNDP database
FDI	Foreign direct investment net inflows (% of GDP)	WDI database

For that reason, while doing the literature review potential variables were selected for better insights into the complex relation among the sustainable development components. Hence, in the table above the variables of our model along with their indicators and sources [18] can be found depicted for better interpretation.

In the table above most ways of variables measuring can be understood, yet for the less common variable: EPI, a little bit more of information will be provided. In regards to the measure of the environment variable, with the intention of

[18] The sources for the indicators where tried to be kept as homogenous as possible for better results, however some variables where better collected in other databases making it harder to keep only one source.

bringing a more well-rounded way of assessing and comprehending nature (as opposed to simply looking at the emissions data), the EPI will be used. This index consists in the scoring of about 32 performance indicators with 11 issues categories which are then weighted into the EPI, the final index score goes from 0-100; the higher the score the better the environmental performance of that country.

Moreover, in a theory oriented approach, while reviewing the results of our model several hypothesis need to be remembered. As mentioned earlier, one of the most predominant hypothesis is the EKC in which economic growth and CO_2 emissions are stated to have an inverted U-shape, in which degradation is greater at the earlier stages of growth but after a certain milestone in income and a peak in degradation is reached further growth will benefit the environment (Frankel, 2009). Likewise, the Pollution Haven Hypothesis (PHH) should be taken into account; in the PHH it is said polluting firms tend to move to countries with lenient environmental policies when regulations are set in place in their home country; meanwhile, the Porter Hypothesis basically envisions an opportunity for polluting firms, they get the chance to innovate and increase their competitiveness, benefiting from stringent environmental policies (Ranocchia & Lambertini, 2021).

Although, we are not reviewing firms, offshoring and environmental policy stringency, these hypothesis can be helpful to recognize why some countries may resist to the green movement despite the fact that their natural capital is being undervalued, and their people are suffering the consequences of global warming, climate change and environmental deterioration. The reality is that event though the people are pressuring governments to take action and the effects of the climate crisis are less and less ignorable, a lot of countries are still adamant to change; and

greenwashing[19] is another problem not only in the politic front but also within firms.

2.2. Model Specifications

The model for this study is based in a simple linear regression with country and year fixed effects, in which EPI would be our dependent variable while the independent variables are income, economy size, trade, density, scholarity and since we want to grasp the influence associated to the new green movements specially after the 2015, there will also be a dummy variable for 2015+ years. Therefore our main model[20] equation will be written as follows:

$$\ln GDP_{ct}+\beta 4Trade_{ct}+\beta 5\ln Density_{ct}+\beta 6Scholarity_{ct}+\beta 7\ 2015post_{ct}+\delta_t+\ \varepsilon_{ct}$$

Where EPI_{ct} represents the score of the EPI and $\ln GDPpc_{ct}$ is the natural logarithm of gross domestic product per capita, $\ln GDPpc_{ct}^2$ is the square of the natural logarithm of gross domestic product per capita, $\ln GDP_{ct}$ is the natural logarithm of gross domestic product, $Trade_{ct}$ is the trade percentage of the GDP, $\ln Density_{ct}$ is the natural logarithm of population density, $Scholarity_{ct}$ is the mean years of schooling, and $2015post_{ct}$ is a dummy variable where it equals 1 when the year is 2015 or posterior to that date. $\beta(1,...,7)$ are the coefficients related to each one of the independent variables, α_c is the fixed effect or individual effect of country, δ_t is the timespecific intercept and ε_{ct} is the error term; all of the explanatory variables are ascribed to $_{ct}$ meaning country and time fixed effects.

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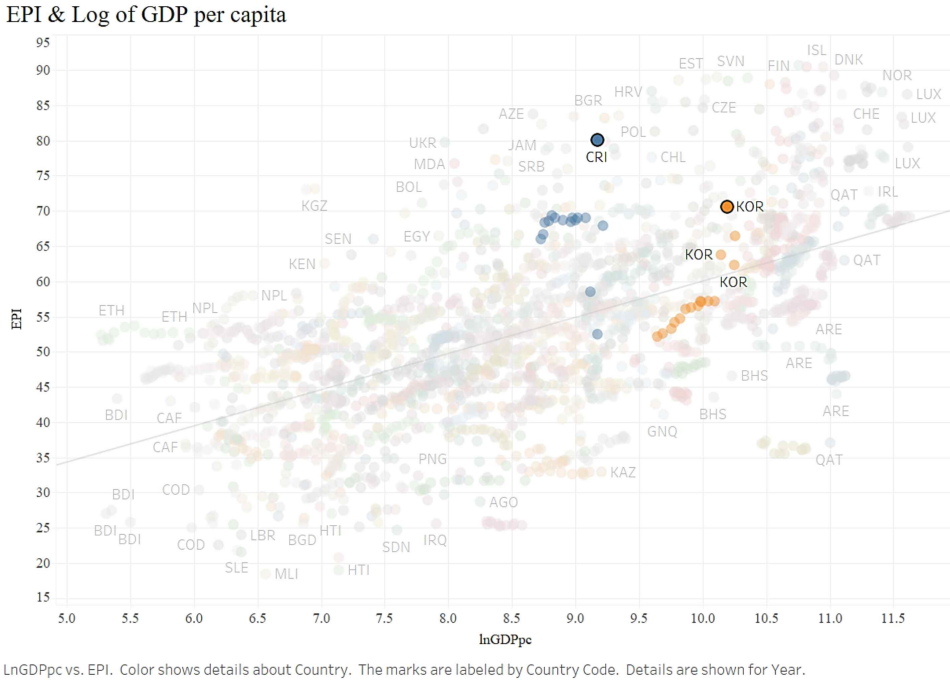
[19] The way some companies try to communicate their way of addressing environmental issues without substantially taking real actions (Walker & Wan, 2014, p. 227).

[20] For the present study we will run two regressions, the base model and the FDI model; the second one will have the exact same equation as the main mode, the only difference is the additional explanatory variable of FDI ascribed by country and time as well as the other explanatory variables described in the base model.

3. Results

To start we should analyze the relationship between the environment and income variables; these are measured by the EPI and the log of GDP per capita. However, since our environment variable is different than typical deterioration measures like CO_2, the inverted u-shape from the EKC should actually be flipped; because in contrast to the emissions the higher the value of the EPI the better the quality of the environment, therefore following this hypothesis with higher income level the EPI score should also increase.

Figure 8. EPI & Logarithm of GDP per capita: Costa Rica and Korea Highlight[21]

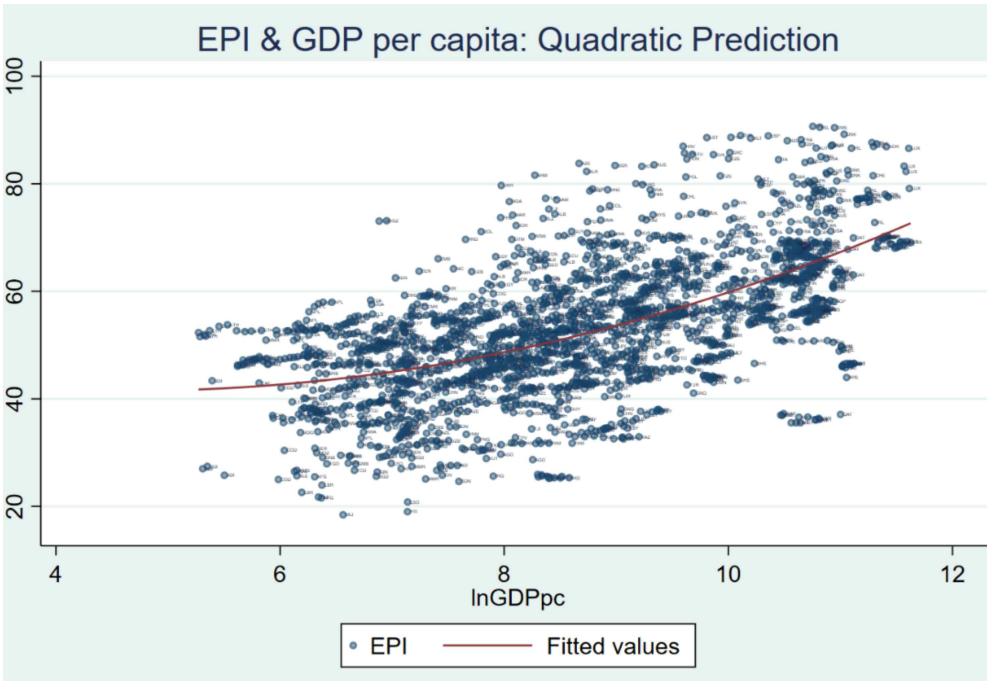


On the graph above we can see the linear trend between the EPI and the

[21] Own preparation with raw data from the EPI and the WDI.

logarithm of GDP per capita for the whole 153 countries within the studied period. Regrettably, we cannot observe the specific time variation clearly[22], nonetheless through this graph we can see how there is somewhat of a trend responding positively to the EKC's basic idea: the countries with higher income tend to also score higher in the EPI, meaning better environmental quality.

Figure 9. EPI & Logarithm of GDP per capita: Quadratic Prediction[23]



With the intend to further observe the grounds of the EKC within the data, the graph above lets us better visualize the curve with a quadratic prediction of the fitted values; meaning, predicting y using x and x^2 or in our case predicting EPI_{ct}

[22] For that reason in the preliminary data section under the EPI portion, Costa Rica's and Korea's trend was presented with more details per year score; likewise in the Annex 5 and 6 the trend followed by other countries like the best and worst countries historical and 2020's performance can be observed.

[23] Own preparation with raw data from the EPI and the WDI.

using $\ln GDPpc_{ct}$ and $\ln GDPpc_{ct}^2$. In theory, since this curve is going upwards it could represent the associated influence of the green movement in the world and the proliferation of stringent environmental policies in combination with higher income levels. But with this graph alone we cannot have the necessary confidence that this is the case, which is where the regression results of our model come into play.

Before getting into the coefficients lets talk about the robustness of our base model; firstly we have the f-test, with a value of 0.001, meaning we can have a 99 confidence rejection of the null hypothesis (H_0), secondly there is the r-square, our results suggest that 53% of the variation in the EPI can be associated to our explanatory variables. While for each one of the coefficients, except for *trade percentage* and *constant* we attained a 0.001 confidence level to reject H_0.

Now, in the table below we can see our regression results, and it is clear that our *income* coefficients actually behave differently, the logarithm of GDP per capita has a negative coefficient of -96.92 while the square of the logarithm of GDP per capita has a positive coefficient of 3.865; these coefficients behave this way because in order to see the curve from the EKC we need a quadratic prediction.

Following this hypothesis, we will find that based on the variables coefficients there is a possibility of multiple existing relationships between environmental quality and economic development. It basically states that if $\beta 1 \ln GDPpc_{ct} > 0$ and $\beta 2 \ln GDPpc_{ct}^2 < 0$ then the degradation associated with initial economic development could decrease once a milestone in growth is reached (Manta, et al., 2020).

Table 2. Regression Results

Outcome Variable: EPI	***Base Model***	***FDI Model***
Log of GDP per capita	-96.92***	-97.03***
	(9.959)	(10.01)
Square Log of GDP per capita	3.865***	3.839***
	(0.321)	(0.323)
Log of GDP	34.21***	34.59***
	(7.818)	(7.871)
Trade percentage of the GDP	0.00907	0.00809
	(0.00885)	(0.00893)
Mean Years of Schooling	1.000***	1.027***
	(0.279)	(0.281)
Log of Population Density	-33.53***	-33.80***
	(7.918)	(7.970)
2015 post dummy	13.55***	13.49***
	(0.432)	(0.436)
Foreign direct investment net inflows (% of GDP)		-0.0117
		(0.00691)
Constant	-132.2	-138.2
	(95.48)	(96.23)
Observations	1823	1801
R-squared	0.529	0.527

Standard errors in parentheses * p<0.05 ** p<0.01 *** p<0.001

Next we have the log of GDP, with this variable we intended to control the *economy size* through a production lens instead of population, since population density can be more of an explanatory variable in a pollution context. Interestingly enough the log of GDP has a positive coefficient of 34.21; meaning that national income can be associated with a higher EPI score.

Then, we have trade percentage of the GDP, according to our tests this coefficient is not statistically significant, nevertheless it is intriguing to see it has a very small coefficient that is barely positive: 0.00907. Subsequently, we find mean

years of schooling, which has a coefficient of 1; suggesting we could imply a positive impact of education on environmental quality.

On the other hand, population density can be associated with a negative influence on the environment, since we got a -33.53 coefficient. And lastly, our dummy variable; with the intend to observe the influence of the green movement, the landmark on environmental efforts of the Paris Agreement and the Sustainable Development Goals served as a reference for reviewing the environmental quality before and after this historic movement. And although scientists and environmentalists are sceptic about the real compromise due to the little accomplishments of goals, there seems to be somewhat of a positive relationship to environmental performance after 2015. Our model indicates a coefficient of 13.55 for our dummy; linking the positive influence of the 2015^{+} with a higher EPI score.

Now, for the FDI model when it comes to tits robustness the numbers are basically the same as the base one. We have an f-test of 0.001 and an r-square 53%; and regarding the significance of the expanatory variables coefficients trade remains statistically insignificant and positive with 0.00809, while FDI turned out to be insignificant too but negative with a coefficient of -0.0117. By adding the FDI variable, most coefficients remain escencially the same; however it might be relevant to mention that most of them increased by a couple of decimals except for $\mathrm{lnGDPpc}^2_{ct}$, Trade_{ct}, and $2015\mathrm{post}_{ct}$ which decreased only by a few of decimals. For that reason we could say, that the influence of the FDI for our model is not that relevant in actuality[24].

4. Implications

For the implications sector we will have two sections, the first one called

[24] See Annex 7 for better visualization of the similarities between the model results.

"other relevant factors" where we deal with additional variables that can help explain the differences between the predicted values and the real values of Costa Rica and Korea's environmental quality but were not included in our model. And a second section called "general model implications" in which we analyze the results from variables included in our model.

4.1. Other Relevant Factors

For this section, we will divide them into pertinent environment measures and social considerations in which additional variables that were not included in our model and that might affect the true environmental health of the countries under study. To better understand how the predicted values differ from the real EPI scores we should look at the table below in wich both Costa Rica's and Korea's scores are tabulated against the predicted EPI scores under our model: $\hat{y}$.

Table 3. Model's predicted ($\hat{y}$) vs. real EPI scores (y)

	Costa Rica			*South Korea*		
		$\hat{y}$			$\hat{y}$	
Year	***EPI***	Base Model	FDI Model	***EPI***	Base Model	FDI Model
2000	65.9619	-2.5245	-3.34057	52.15335	30.16561	29.72033
2001	66.69805	-2.48472	-3.28548	52.58821	30.79876	30.36168
2002	68.36656	-2.39251	-3.19975	53.26799	31.88707	31.44784
2003	68.53317	-2.31739	-3.13494	54.2036	32.45892	32.01349
2004	69.32506	-2.13663	-2.97557	54.67056	33.31863	32.85088
2005	69.0201	-1.95342	-2.82054	56.03918	33.95668	33.48829
2006	68.64723	-1.60561	-2.48616	56.28623	34.55904	34.08413
2007	68.42636	-1.0125	-1.90045	56.53851	35.4363	34.9503
2008	68.63357	-0.48174	-1.36171	57.19108	36.19126	35.6795
2009	69.02813	-0.76981	-1.59675	57.07095	35.66079	35.14799
2010	69.02813	-0.61016	-1.44188	57.2028	37.04005	36.51973
2012	69.03	0.086187	-0.75812	57.2	38.30009	37.76541
2014	58.53	0.666093	-0.17957	63.79	39.25132	38.72631
2016	80.03	14.44576	13.54914	70.61	53.57362	52.99468
2018	67.85	14.93701	14.03315			

As it can be seen from the table above, both our models fall short to give a close prediction to the EPI, especially for Costa Rica's case. The root of these limitations lie in the fact that for an economy, some key issues in sustainable development cannot be completely captured by the explanatory variables in our models; and the issue here is that in order to capture these other variables more data is needed to be collected universally. Additionally to the lack of the data, the topic is considerably recent, and some countries have yet to start making progress in the sustainability area. Also, since each country has its particular necessities, a comprehensive widespread way to record the data for sustainability worldwide is still on early stages. Nevertheless, in order to better understand the discrepancies between the predicted $\hat{y}$ by our model and the real EPI scores[25], some other important factors need to be addressed even if data might be scarce; and thankfully for both of our countries under study we can still observe some relevant data.

4.1.1. Pertinent Environment Measures

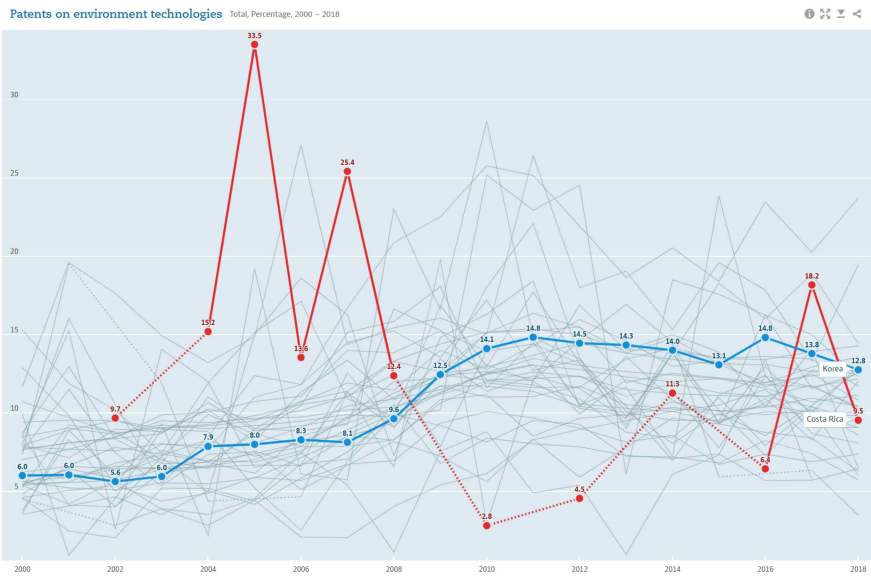
When it comes to the indicators of environmental health the list can be rather overwhelming, for that reason instead of tackling down all the categories included in the Environmental Performance Index (EPI), some of the most common focal points while talking about climate change will be revised. First, since a helpful tool for this shift are environmental technologies we will be examining the latest OECD statistics about patents on environmental technologies.

For Costa Rica and Korea in the period 2000-2018 it looks like the percentage of patents has being actually decreasing in the most recent years, however while reviewing patent data it is also prudent to remember that not all innovations are patented and therefore would not be reflected on this data. Still, for a climate

[25] For more information about residuals see Annex 8.

change crisis like the one we are living right now, it looks as if that number needs to go up; hence the governments should also improve their research and development (R&D) strategies.

Figure 10. Total percentage of patents on environmental technologies OECD countries[26]



4.1.1.1. Energy

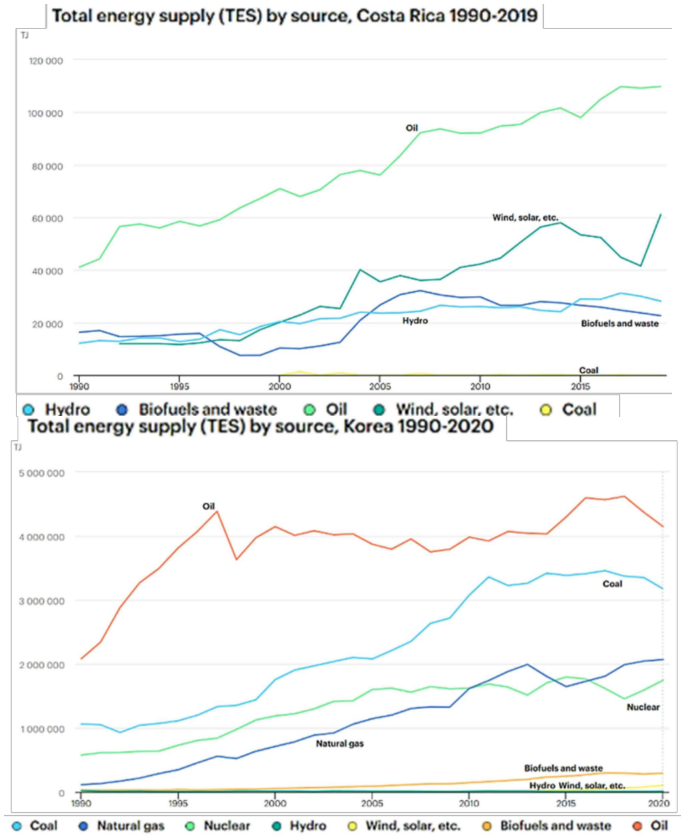
When it comes to energy the whole world is in search of reducing emissions via more efficient and renewable ways, Korea and Costa Rica are not the exception Though, since their energy sources are quite different they will have to tackle challenges unique to their infrastructure. As most countries, Korea has a source issue, meaning, there is a need to be greener and opt out of older and more pollutant options like coal, one of their main sources (IEA). Nonetheless, for Costa Rica in specific it is mentioned in the 2016 report that given the already sustainable grid of electricity[27] which is more than 98% since 2014 the country could lose

[26] Source: OECD Data website.

[27] See Annex 9 and 10 for a graph on electricity generation by source for Costa Rica and

momentum and it is also clear in their decarbonization plan that in order to fulfill carbon neutrality the country needs to step up their game. Most of the world is currently shifting their energy sources, and as seen in the COP26 one of their major goals is to stop the usage of coal (UK COP26, 2021); the energy shift is a really big step towards sustainability but it can be one of the easiest to achieve[28].

Figure 11. Costa Rica and Korea Total Energy Supply by Source[29]



South Korea from IEA.

[28] As stated by Clare Lombardelli, Chief Economic Adviser, HM Treasury, United Kingdom during an OECD Green Talks LIVE: Assesing the Economic Impacts of Environmental Policies back in May 17th of 2021.

[29] Source: IEA (International Energy Agency)

In Costa Rica's case one of their biggest issue is the transport sector (Government of Costa Rica, 2019), the country has a very old float of vehicles, and sadly the older technologies tends to be less eco-friendly. However the cost of living in the country is quite high and being the OECD country with the highest inequality (OECD, 2020b) and poverty rate (OECD, 2020f) the capability of families to upgrade their vehicle is low.

Also, based on their decarbonization plan, the public transport is lacking a lot, not only are the vehicles old but also the lines and routes available to the public are very scarce and not reliable, reason why the country is also dealing with issues like heavy traffic because the citizens would prefer to save up and buy an old car than trusting the public transportation system.

4.1.1.2. Emissions

Carbon emissions reduction is usually the most cohesive and one of the first targets to set when it comes to the shift to a greener economy internationally, yet the complex nexus that exist between economic growth and carbon emissions makes it exceptionally intricate to separate or unravel the causes from the economic activities. For that reason, the 2016 EPI's climate and energy indicators esentially focus on the way countries are decarbonizing their economic growth more than the tangible effects of their policies on climate (Hsu, et al., 2016, p. 16).

When examining the relationship between environment and economic growth the amount of emissions is usually a crucial part of the calculations. Most researchers usually measure the environment health through the amount of emissions since it is the source of several concerns; a predominant hypothesis on this field is the Environmental Kuznets Curve (EKC).

The EKC hypothesis essentially tackles the relationship between environmental degradation and income per capita; in which it is stated that at the initial stages of developing economic growth will be detrimental to the environment, due to the increase of economic activities. However, as the country and the economy gets more developed there a development level will be reached and prior environmental quality can start to be restored; indicationg the possibility of a turning point and reflecting the intricate nexus between economic development and the environment. Additionally it can be important to mention that the EKC was originated from the modified application of a theory on the relationship between inequality and growth that is depicted in an inverted-U curve (Maneejuk, Ratchakom, Maneejuk, & Yamaka, 2020, p. 2).

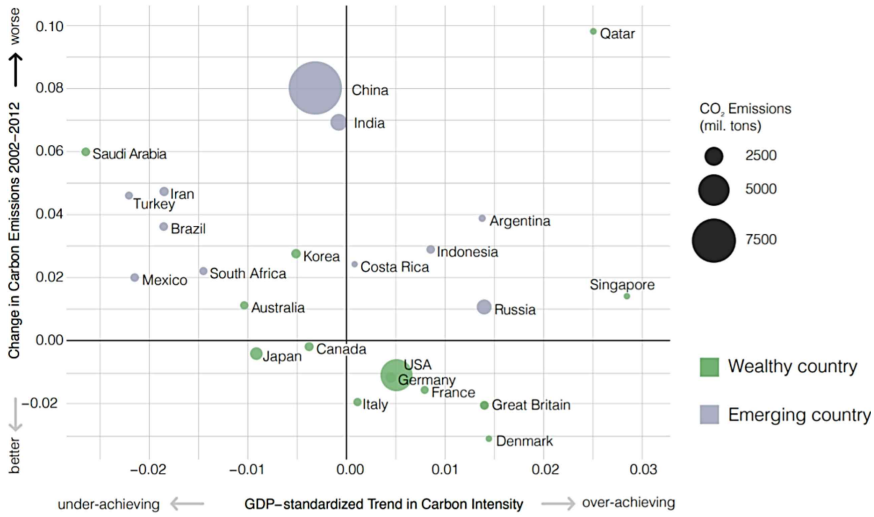


Figure 12. Selected countries, gauged according to the GDP-standardized Trend in Carbon Intensity and Trend in Carbon Emissions[30]

In South Korea's there is a constant reminder of the environmental deterioration, because emissions are not only a way to try and quantify the deterioration of the planet, but they also hold genuine risks to human health in the

[30] Source: 2016 EPI.

form of air pollution; still, the Korean people might have already gotten used to living with it. According to the 2016 EPI more than 50 percent of its population is currently being exposed to unsafe fine particles which are polluting the air; while living in Korea air pollution is almost a daily issue which evidences the need for a rougher strategy from the government. Yet, it is also important to recognize that while talking about environmental economics one is able to see how some of the environmental costs and benefits can be external, and therefore influenced or affected by other parties (Antikainen, et al., 2016), for that reason its closeness (geographically speaking), with big polluters like China might also play a big role in the health risks and challenges Korea has to overcome.

Nonetheless Korea is not the only country in this predicament. Given the nature of some impacting factors, and taking into account the role of globalization; a unilateral approach to this problem is not sufficient. It is exactly why international efforts to control the externalities and make everyone accountable are increasing. Though, some countries are not pleased with this idea; since developed countries got their chance to develop without rules and use all the resources they wanted and more, some see this as somewhat hypocritical and unfair; and their discomfort is in fact fairly reasonable if we base it on the EKC hypothesis.

4.1.1.3. Water

In regards to water indicators, Costa Rica specially has a long-road to follow, the issue with water in this country is not the availability, the connections or the quality. It is more an issue of wastewater treatment. In Costa Rica's 2020 EPI score the water resources indicator; (which means wastewater treatment[31]) was the lowest[32], it can also be noticed in the graph below where the red line is clearly

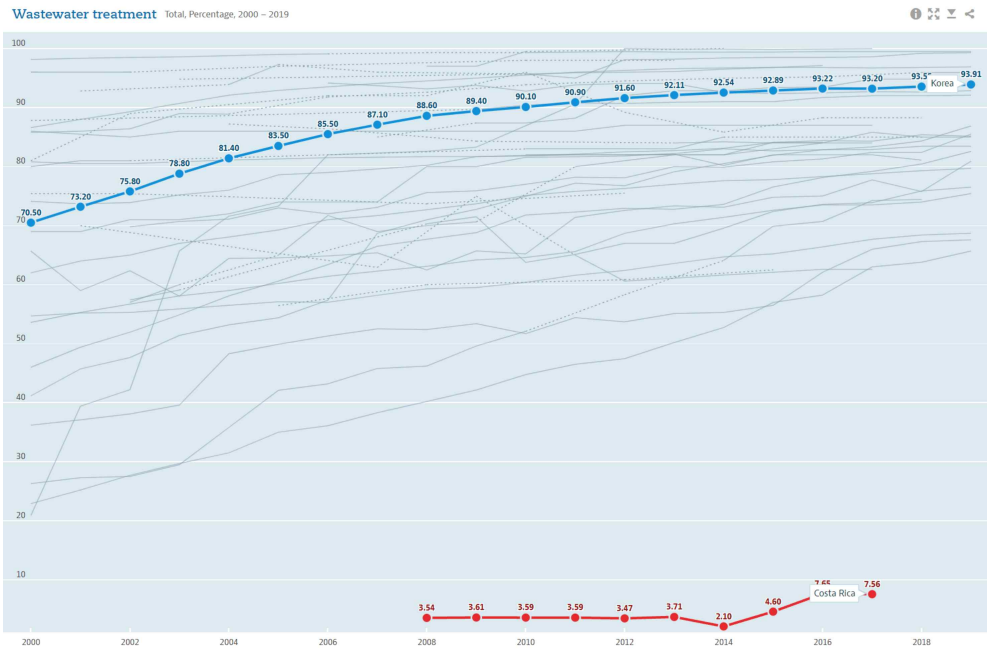
[31] (Wendling, et al., 2020, p. 15)

[32] (EPI, 2020) ESRI Living Atlas.

lacking.

Here it is clear how behind Costa Rica is in terms of water treatment, the percentage of population connected to wastewater treatment plant is drastically minimal. The highest ever recorded percentage was 7.65% back in 2016 which in comparison to the rest of the OECD countries is significantly low; demonstrating the tremendous need Costa Rica has for better wastewater management.

Figure 13. Wastewater treatment percentage OECD countries[33]



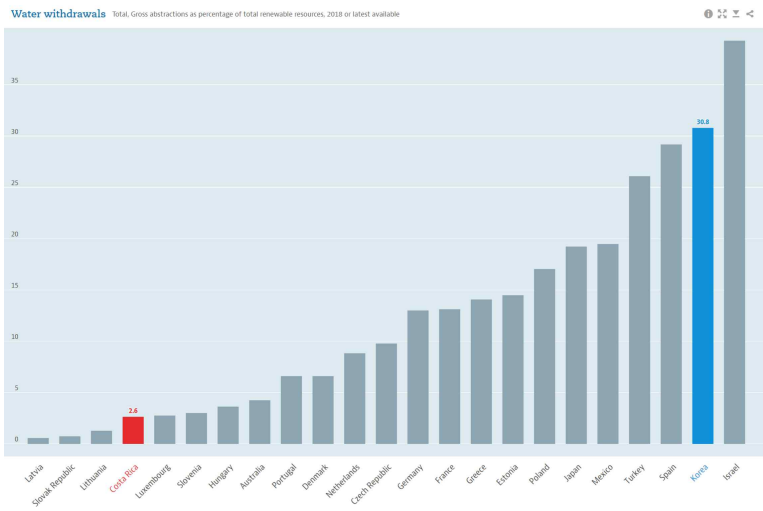
Korea in this term is actually in the top of the members with over 93% of its population connected to a treatment plant. However, when it comes to water withdrawals the coin is flipped; this is not directly harmful but it can lead to water depletion as well as loss of water quality from the ground.

In this aspect Korea has the second highest percentage of gross abstractions as percentage of total renewable resources within the OECD members. Meanwhile

[33] Source: OECD Data website.

Costa Rica is in the bottom part with only 2.6%, yet it is important to know that water for hydroelectricity generation has been excluded in this OECD measure, and since Costa Rica's energy grid is mostly support by hydro energy, this would not be represented within this abstractions percentage.

Figure 14. Water withdrawals: abstraction percentage of total renewable sources OECD countries[34]



4.1.1.4. Protected Areas & Land Coverage

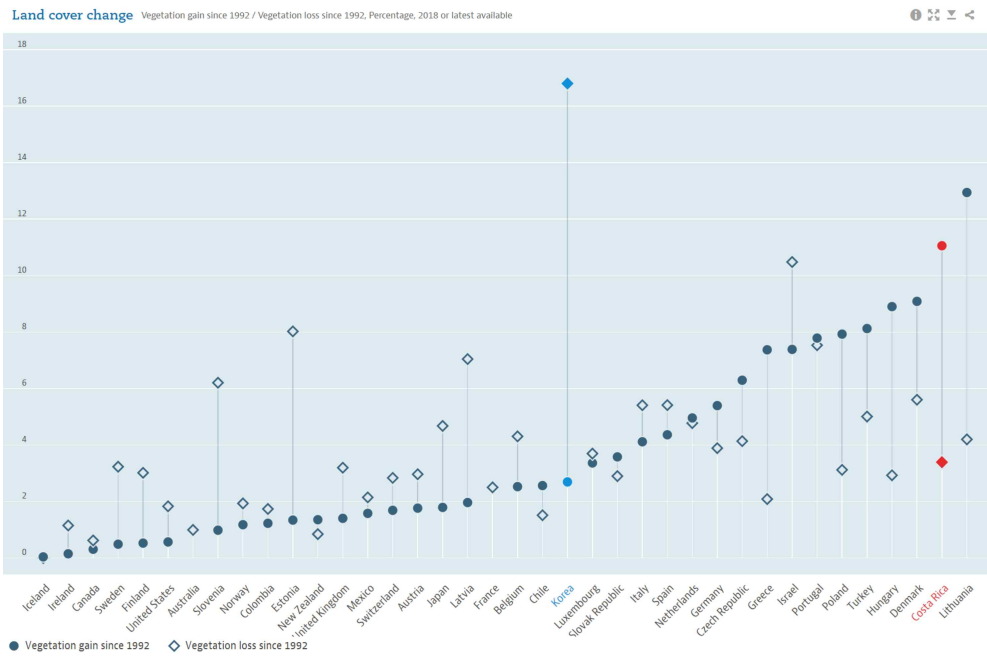
In terms of emission minimization one given factor that countries usually count as a beneficial aspect is the emission absorption from the forest coverage, however one mistake that politicians specially make is to expect the forests of the world to absorb way too big of a fraction. Also, the percentage of protected areas and land coverage of forestry is having a decreasing tendency, which is evidently not beneficial; in the graph below the vegetation gains and losses since 1992 are detailed by country from the OECD members.

In it we can see how big of a negative impact the pass of the years have had in Korea's vegetation with a 16.8% of loss since 1992, overpowering the gains of

[34] Source: OECD Data website.

only 2.7%. Meanwhile, Costa Rica has higher gains; there is an increase of 11.11% in the vegetation against 3.4% of losses. Additionally to these measures, another important indicator is the level of protected areas, because the more protected areas there are the more potential forest there will be to absorb emissions.

Figure 15. Land Cover: vegetation gains and losses since 1992 -OECD[35]



According to the graph, Korea is in the lower half of the OECD countries with just 16.9% of the total land area while Costa Rica is in the top half with 30.6%. However in this aspect we should also consider the total size of the countries because Costa Rica is a known small country, meaning that the external benefits it can bring to the world might not be as substantial as bigger countries. Nonetheless, since the ocean is "the largest carbon sink[36] on earth" (Ocean & Climate Platform),

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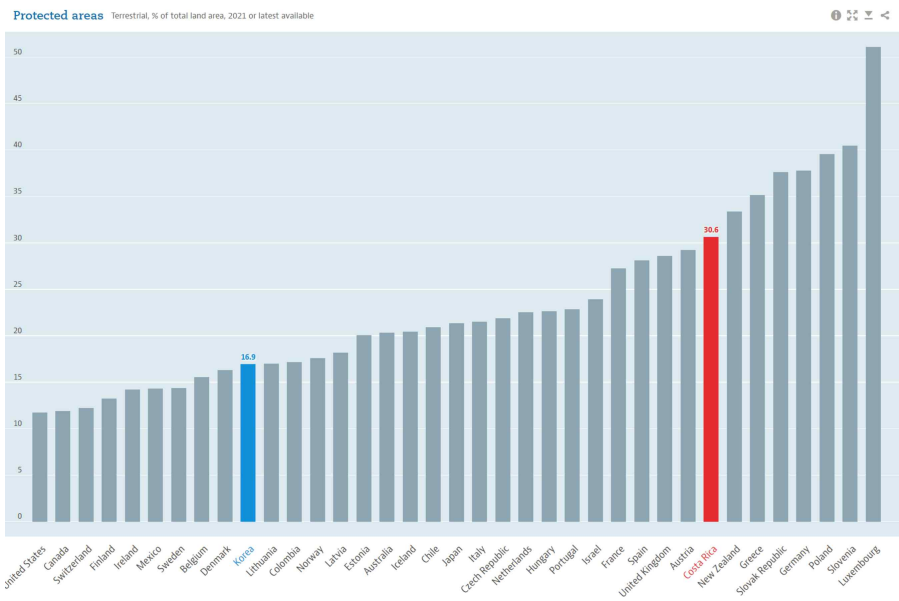
[35] Source: OECD Data website.

[36] A carbon sink can be either an artificial or a natural reservoir which absorbs the carbon in the atmosphere. Some examples of carbon sinks would be limestone, oil, methane hydrate, coal and natural gases; which can be essentially thought of as "containers" or "holders" of

and Costa Rica's territory is bigger in the water it seems relevant to mention that within the protection reformed mentioned earlier they also established several initiatives to protect their oceans and wetlands.

Figure 16. Percentage of terrestrial protected areas: OECD members[37]



4.1.2. Social Considerations

In addition to the preview data, other variables that have a more social impact need to be consider while trying to understand the current state of the countries under study. In the new concepts of development, most international organizations consider the necessity of adding social and environmental markers, due to the clearly need of a holistic measure of welfare and development, economic growth is

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carbon. However, when we use the resources from these "holders" we are burning fossil fuels in actuality, releasing the carbon they were absorbing into the atmosphere. At last, there are other forms of carbon sinks that have a more greener approach, some of these are vegetalizing environments like forming forests, humus storing soils as peatlands and as previously mentioned the ocean and other marine environments in which physical and biological processes are performed (Ocean & Climate Platform).

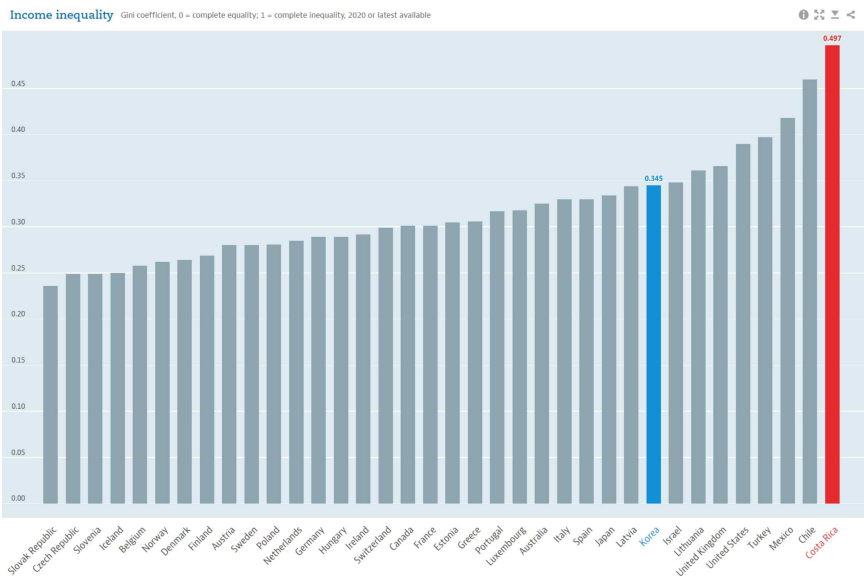
[37] Source: OECD Data website.

insufficient and the reality lived by the people can be far off.

4.1.2.1. Inequality and poverty

First, since GDP is the most traditional way of measuring growth and development one of the main issues would be disparity in the distribution of income. According to the next graph, in 2020 from the OECD members Costa Rica posses the highest inequality, with a Gini coefficient of 0.497; meanwhile Korea, is lower than Costa Rica, although it is still in the higher half with 0.345 coefficient.

Figure 17. OECD countries Income Inequality[38]

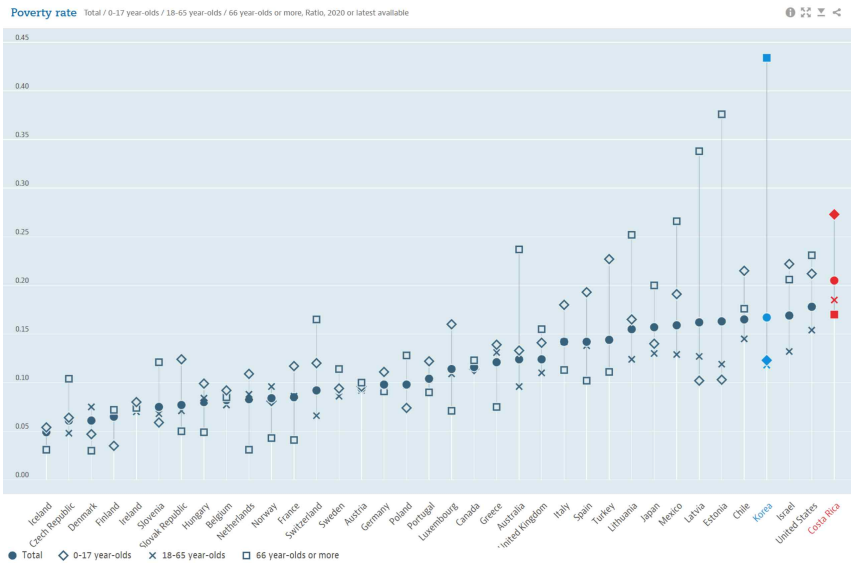


Second, another social issue directly related to income is poverty. For that reason the Poverty Rate data will also be explored. Within the OECD the countries in 2020 Costa Rica's poverty rate is the highest ratio of total poverty which is around 0.20, with the age group of 0-17 years old being the most vulnerable. In Costa Rica child labor is illegal, meaning that youngsters under 15 cannot participate in any economic activity legally; but the teens between 15-17 need a labor permit which is given under certain regulations (U.S. DOL Bureau of

[38] Source: OECD Data Website.

International Labor Affairs, 2020), issue that could be affecting this age group's vulnerability even more if they do not have the support of a family with more economic means.

Figure 18. OECD countries Poverty Rate[39]



Now, with a total ratio of 0.167 Korea is not that far up from Costa Rica; moreover, if age gaps are analyzed specially the older Korean population is under quite the quandary. As seen in the graph above, the 66 year old and more age group is the most vulnerable group to poverty within the OECD economies; and with the known level of innovation of this economy (WIPO, 2021), the opportunities to be part of the labor force for this group can be expected to be even more reduced, directly affecting their capacity to increase their income and therefore the national poverty line.

4.2. General Model Implications

Now, following our results we can say that income seems to have a

[39] Source: OECD Data Website.

predominantly strong relationship with the EPI score, which consequently reflects the state of the environment through performance indicators. This depicts the complex relationship between environment and economic growth; and this could be due to the development strategy or infrastructure of a country.

With new approaches to development like green growth the relationship between income and environment could become positive if a real shift is implemented. However, the linear economy system has been proven challenging to transform; and some countries keep the full-on resources mindset where the life cycle and material flow are underplayed with the end of ever-increasing consumption.

At the same time, the national income seems to be providing more resources to tackle environmental issues; maybe the increase on GDP could also represent and increase in investment, innovation and R&D, all key factors to a greener future In order to fulfill our promises of not compromising future generations resources innovative technologies and new ways of living need to be adopted; and newer ideas cannot only translate to the enhancing of the environment but also to more profitable concepts and designs that can also advance our economic development and financial capacity.

In addition, trade can be a tool for the exchange of technologies and a vehicle for better international standards of production. Following the Porter Hypothesis, international firms can become more competitive due to innovation and more conscious lines of production; in previous cases there have been moments where trade and offshoring have brought benefiting policy inclinations within the host country in areas like human rights and innovation; thus for the environment revolution the spill-over effect could also be substantial (Frankel, 2009).

However, the trade issue should also be considered from the polluting aspect,

where several countries' exports are focused on cheap, short life cycle consumables with the intend of constant discarding and repurchasing (Delchet-Cochet, 2020), as well as the emissions not only while producing but also on transport. International trade has been adapting to newer demands of greener and more ethical products (Bhardwaj, 2016), now that the consumers have more access to information and are better educated on the matter, leading to higher standards at the time of buying goods (Ağan, Kuzey, Acar, & Açıkgöz, 2016). Education can have an important role in environment protection, not only in terms of knowledge about the actual crisis but also as an input for the search of possible solutions to the current climate crisis.

One more relevant issue while thinking about environmental quality is population density; as previously stated in the preliminary data, despite the fact that there is inconclusive evidence on this phenomenon, most of the research had somewhat of a positive relationship between emissions and density. This could explain the reasoning behind the results we got on our model; if the density is high and there are not enough green areas to absorb the gasses created by the population then environmental quality could decrease. Likewise, when the population is concentrated also the resources around need to be conscientiously consumed, otherwise issues like resource constraints can be developed, putting more stress on nature's balance.

For that reason, it is important that more and more countries ultimately shift from a linear economy mindset to a circular economy strategy, but in order to complete this tasks international support is needed. As a result, landmarks like the Paris Agreement need to stop being considered as milestones and start becoming more mainstream, for a lot of countries the targets set on the Agreement can be difficult to reach but the experts have stressed the importance of more ambitious

goals since the current state of the globe is such that even if we hit the Paris Agreement marks we will need profounder changes in our society.

Following the findings of our model, it can be said that global efforts like the previously mentioned can potentially influence bigger change by making countries compromise to take action on the matter. And even if it is not a huge target or goal the year 2015 meant something for the world, perhaps if there were more initiatives like these where provoking proposals are developed the reaction generated could be grater.

Let's take a country like Costa Rica, where the policy shift has been taken on by the government to strengthen their green growth. Initial policies that intended to improve the deforestation issue they had in the early 90's have evolved into a program where several citizens can get an incentive to take care of nature while receiving some sort of income from it; which inherently caught the attention of international counterparts interested in supporting the Programme, not only bringing financing but also a better reputation (FONAFIFO, 2018). This same policy even leaded to the win of the Earthshot Prize for Protect and Restore Nature category, making the country the recipient of a one million-pounds prize (The Earthshot Prize, 2021).

And in the case of Korea, the country that has been pushing for more and more environmentally friendly policies, which have taken them to a better position in the EPI world ranking. The infrastructure and resources that Korea holds gives it a bigger margin to reach good results; for example, Costa Rica's wastewater treatment and transport issue is an expensive and challenging task that in Korea's case can be easily overcome due to its existing economic and urban development, for that reason we see how much of an impact the *income* variables can have on the quality of environment.

5. Conclusions

In conclusion, the effect of economic development and trade on the environment can be very complex due to the distinct results one economy can get based on their particular growth strategy. Nevertheless, green growth is still a possibility, it just needs the right amount of political will along with the proper configuration of variables for a successful positive relationship between economic growth and environmental quality.

The national income, trade, scholarity and international pressure seem to all have positive impacts on the quality of the environment; therefore policies that foster these variables might also be able to ultimately affect positively the environment. However, one of our model's limitation is the lack of more constant data for more all-inclusive environmental metrics as well as more social and economic indicators. In initial runs of the model the Gini coefficient and the foreign direct investments were also part of the calculations (given the recurrence of inequality in the concept of sustainable development and the mention of positive influence of investment into the green economy), but the coefficients were statistically insignificant and the observations number decreased considerable due specially to the Gini coefficient data scarcity; which resulted in the final decision of taking them out from the base model.

Likewise, on our base model we still have one statistically insignificant explanatory variable: trade, since one of the main motives for this study was to also quantify the possible association between trade and environmental quality we kept it in the chosen base model even if the coefficient was also found to be an extremely weak and insignificant. However, since FDI might still seem relevant to keep on the study, the second model was also added to the study as evidence, eventhough the results are exceptionally similar to the base one.

On the other hand, we also saw how population density and growth could have negative effects on the environment. Results that could help evidence the need for a transition to a green and circular economy where resource efficiency, dematerialization and bioeconomy is a given and not a utopian target, where green infrastructure is the norm, green washing is obsolete and waste is given the proper management.

In regards to our chosen countries, even though the predicted values of our models clearly under predicted the EPI, the obtained results serve as evidence that there are several ways of pursuing green development. Through the examination of both countries statistics we could say that their current state is somewhat backed by the results seen on our regression; in the sense that, national income can have an associated positive tendency in environmental quality.

However, since both countries have had different priorities; it has obviously made their shortcomings very unique to each one of them, nevertheless we could agree that the unanimous target is to reduce GHG. In order to do so, Costa Rica really needs to focus on wastewater management as well as their transport sector, while Korea needs to focus on their energy and air pollution issues as well as stronger GHG emissions policies-NDCs.

Yet, in order to positively transform our economies more action is required, mitigation is important but is not the only issue to tackle. Countries need to additionally find more sustainable economic activities and facilitate the human capital to be ready for such changes. In this day and age the transformation of the market labor is indisputable either if it is based on technologies changes like artificial inteligence or eco-friendly innovation this will be another issue economies should take into account.

Especially in the sustainable development concept we see the constant

mentioning of social equity and general social considerations brought on the table. However, since the topic is quite recent more data is needed and even if the labor market was not tackled in the present study it could be an interesting approach for further investigation.

Based on our models results we can see that the EKC hypothesis can partially explain the intricate relationship between economic growth and the environment, but more data is required to further understand said relationship. Furthermore, the availability of data will also result pertinent at the time of generating and designing green development strategies.

This data should not only be better collected at international level but also be prioritized by national statistical offices. As it is mentioned throughout the study each country possesses intrinsically unique characteristics and there is not set path for successfully transforming into a green economy; yet more efforts should be made in order to reach it because it has been proven that sustainability does not have to mean the detriment of economic growth and that in actuality both are capable of thriving hand-in-hand.

6. Bibliography

Abeygunawardena, P., Agrawala, S., Caspary, G., Debois, M., Foy, T., Harrold, M., . . . Vyas, Y. (2009). *Poverty and Climate Change: Reducing the Vulnerability of the Poor through Adaptation.* Retrieved from https://documents1.worldbank.org/curated/en/534871468155709473/pdf/521760WP0pover1e0Box35554B01PUBLIC1.pdf

Ağan, Y., Kuzey, C., Acar, M. F., & Açıkgöz, A. (2016). The relationships between corporate social responsibility, environmental supplier development, and firm performance. *Journal of Cleaner Production, 112*(3), 1872-1881. Retrieved from http://lps3.doi.org.libproxy.snu.ac.kr/10.1016/j.jclepro.2014.08.090

Akenji, L. (2014). Consumer scapegoatism and limits to green consumerism. *Journal of Cleaner Production, 63*, 13-23. Retrieved from https://doi.org/10.1016/j.jclepro.2013.05.022

Anbumozhi, V., Kalirajan, K., & Singh, K. (2010, August). *Measuring the Environmental Impacts of Changing Trade Patterns on the Poor.* Retrieved from Asian Development Bank Institute: https://www.adb.org/sites/default/files/publication/156094/adbi-wp239.pdf

Antikainen, R., Droste, N., Hansjürgens, B., Kuikman, P., Leskinen, P., Loiseau E., . . . Thomsen, M. (2016). Green economy and related concepts: An overview. *Journal of Cleaner Production, 139*, 361-371. Retrieved from https://doi.org/10.1016/j.jclepro.2016.08.024

Antoni, E. (2021). *Trade, Development, and Nature - An Introductory Learning Companion.* Geneva: United Nations Environment Programme (UNEP). Retrieved from https://wedocs.unep.org/xmlui/bitstream/handle/20.500.11822/35866/TDN.pdf

BBC. (2018, May 1). South Korea - Timeline. *BBC*. Retrieved from https://www.bbc.com/news/world-asia-pacific-15292674

Becker, J. (1998). The potential of sustainable development in Costa Rica. *Sustainable Development, 6*, 123–129. Retrieved from https://doi.org/10.1002/(SICI)1099-1719(199812)6:3<123::AID-SD96>3.0.CO;2-K

Bhardwaj, B. R. (2016). Role of green policy on sustainable supply chain management: A model for implementing corporate social responsibility

(CSR). *Benchmarking: An International Journal, 23*(2), 456-468. Retrieved from http://lps3.doi.org.libproxy.snu.ac.kr/10.1108/BIJ-08-2013-0077

Borck, R., & Schrauth, P. (2021). Population density and urban air quality. *Regional Science and Urban Economics, 86*. Retrieved from https://primoapac01.hosted.exlibrisgroup.com/permalink/f/gpkqdp/TN_cdi_gale_infotrac_648994215

Bosetti, L., Salvioni, D., & Gennari, F. (2016). Sustainability and Convergence: The Future of Corporate Governance Systems? *Sustainability, 8*(11), 1203. Retrieved from https://doi.org/10.3390/su8111203

Bowen, A., Stern, N., & Whalley, J. (2014). *The global development of policy regimes to combat climate change* (Vol. 4). Singapore: World Scientific Publishing Co. Pte. Ltd.

Bretschger, L. (2014). Environment and development: achievements and challenges in climate economics. *Environment and Development Economics, 19*(3), 292-294. doi:10.1017/S1355770X14000199

CAT. (2021, September 15). *South Korea.* Retrieved from Climate Action Tracker: https://climateactiontracker.org/countries/south-korea/

CENCE. (2020). *Información Técnica- Informes Anuales*. Obtenido de ICE: https://apps.grupoice.com/CenceWeb/CenceDescargaArchivos.jsf?init=true&categoria=3&codigoTipoArchivo=3008

Chandukala, S. R., Olsen, M. C., & Slotegraaf, R. J. (2014). Green Claims and Message Frames: How Green New Products Change Brand Attitude. *Journal of Marketing, 78*(5), 119-137. Retrieved April 2021, from http://www.jstor.org/stable/43785840

Chowdhury, S. (2018, November 30). *Sustainable forestry: Republic of Korea has lessons to offer to developing countries.* Retrieved from UNDP: https://www.undp.org/blog/sustainable-forestry-republic-korea-has-lessons-offer-developing-countries?utm_source=EN&utm_medium=GSR&utm_content=US_UNDP_PaidSearch_Brand_English&utm_campaign=CENTRAL&c_src=CENTRAL&c_src2=GSR&gclid=Cj0KCQjw5oiMBhDtARIsAJi0qk3z

Das, G. (2020, May 07). Trade, Environment and Adjustments: Contemporary Themes. *Foreign Trade Review, 55*(3), 271-276. Retrieved from https://doi.org/10.1177/0015732520919837

Delchet-Cochet, K. (Ed.). (2020). Circular economy : From waste reduction to

value creation. John Wiley & Sons, Incorporated.

Dendler, L. (2014). Sustainability Meta Labelling: an effective measure to facilitate more sustainable consumption and production? *Journal of Cleaner Production, 63*, 74-83. Retrieved from https://doi.org/10.1016/j.jclepro.2013.04.037

Ding, Y., Fu, Y., Lai, K. K., & Leung, W. (2018). Using Ranked Weights and Acceptability Analysis to Construct Composite Indicators: A Case Study of Regional Sustainable Society Index. *Social Indicators Research, 139*, 871–885. Retrieved from https://primoapac01.hosted.exlibrisgroup.com/permalink/f/gpkqdp/TN_cdi_springer_primary_2018_11205_139_3_1765

EPI. (2020). *About EPI*. Retrieved from EPI: https://epi.yale.edu/about-epi

EPI. (2020). *EPI-ESRI Living Atlas.* Retrieved from EPI: https://www.arcgis.com/apps/dashboards/8dd0d10f07544331888ecc2a406d1825

Eriksson, C., & Zehaie, F. (2005, April). Population Density, Pollution and Growth. *Environmental and Resource Economics, 30*, 465-484. Retrieved from http://lps3.doi.org.libproxy.snu.ac.kr/10.1007/s10640-004-5985-z

Figueres, C., & Rivett-Carnac, T. (2020). *The Future We Choose: Surviving the Climate Crisis.* Knopf Doubleday Publishing Group. Retrieved from https://ebookcentral.proquest.com/lib/snulibrary-ebooks/detail.action?docID=6072403

FONAFIFO. (2018). *Payment of Environmental Services*. Retrieved from FONAFIFO: https://www.fonafifo.go.cr/en/servicios/pago-de-servicios-ambientales/

Forstater, M., & Zhang, N. N. (2016, September). Definitions and Concepts: Backgound Note. *UNEP Inquiry.* Retrieved from https://wedocs.unep.org/bitstream/handle/20.500.11822/10603/definitions_concept.pdf?sequence=1&isAllowed=y

Frankel, J. A. (2009). Environmental Effects of International Trade. *HKS Faculty Research Working Paper Series RWP09-006*. Retrieved from http://nrs.harvard.edu/urn-3:HUL.InstRepos:4481652

Future Earth; The Earth League; World Climate Research Programme;. (2021, November). *10 New Insights in Climate Science: A year of climate-related science in review.* Retrieved from Future Earth: https://10nics2020.futureearth.org/wp-content/uploads/2021/01/10-new-

insights-in-climate-science-20210127.pdf

Ghadimi, P., Lim, M. K., Tseng, M.-L., & Wang, C. (2019). A literature review of sustainable consumption and production: A comparative analysis in developed and developing economies. *Journal of Cleaner Production, 206*, 741-754. Retrieved from https://doi.org/10.1016/j.jclepro.2018.09.172

Global Carbon Project. (2020, December). *Largest producers of fossil fuel CO2 emissions worldwide in 2019, by share of emissions [Graph]*. Retrieved from Statista: https://www.statista.com/statistics/271748/the-largest-emitters-of-co2-in-the-world/

Gobierno de la República de Costa Rica. (Abril de 2018). Política Nacional de Adaptación al Cambio Climático. Recuperado de http://www.pgrweb.go.cr/DocsDescargar/Normas/No%20DE-41091/Version1/Politica_ADAPTACION_24_abril.pdf

Government of Costa Rica. (2015, September). Costa Rica's Intended Nationally Determined Contribution. Retrieved from https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Costa%20Rica%20First/INDC%20Costa%20Rica%20Version%202%200%20final%20ENG.pdf

Government of Costa Rica. (2019). National Decarbonization Plan. Retrieved from https://unfccc.int/sites/default/files/resource/NationalDecarbonizationPlan.pdf

Govindan, K., Luthra, S., & Mangla, S. K. (2017). Prioritizing the barriers to achieve sustainable consumption and production trends in supply chains using fuzzy Analytical Hierarchy Process. *Journal of Cleaner Production, 151*, 509-525. Retrieved from https://doi.org/10.1016/j.jclepro.2017.02.099

Hickel, J. (2020). The sustainable development index: Measuring the ecological efficiency of human development in the anthropocene. *Ecological Economics, 167*. Retrieved from https://doi.org/10.1016/j.ecolecon.2019.05.011

Hsu, A., Esty, D. C., Levy, M. A., de Sherbin, A., Alexandre, N., Cohen, S., . . . Weeks, C. (2016). *2016 Environmental Performance Index (EPI).* Yale University. doi:10.13140/RG.2.2.19868.90249

IEA. (n.d.). *Costa Rica.* Retrieved from IEA: https://www.iea.org/countries/costa-rica

IEA. (n.d.). *Korea.* Retrieved from IEA: https://www.iea.org/countries/korea

IQAir. (2020). *World Air Quality Report 2020.* Retrieved from IQAir:

https://www.iqair.com/world-most-polluted-countries

Jeong, H. (2018). Analysis of Korea's Long-Term Growth Process and Lessons for Sustainable Development Policy. *The Korean Economic Review, 34*(2), 237-265. Retrieved from https://kiss.kstudy.com/thesis/thesis-view.asp?key=3649758

Jung, T. Y. (2018). *Sustainable Development Goals in the Republic of Korea.* Taylor & Francis Group. Retrieved from https://primoapac01.hosted.exlibrisgroup.com/permalink/f/1qb4pk8/82SNU_INST21803463970002591

Kaufman, S. M. (2012). Quantifying sustainability: industrial ecology, materials flow and life cycle analysis. In F. Zeman (Ed.), *Metropolitan Sustainability Understanding and Improving the Urban Environment* (pp. 40-54). Woodhead Publishing Series in Energy. Retrieved from https://www.sciencedirect.com/science/article/pii/B9780857090461500035

Kim, M.-J., Chang, Y.-S., & Kim, S.-M. (2021, August 26). Impact of Income, Density, and Population Size on PM2.5 Pollutions: A Scaling Analysis of 254 Large Cities in Six Developed Countries. (P. B. Tchounwou, Ed.) *nternational Journal of Environmental Research and Public Health, 18*(17) doi:https://doi.org/10.3390/ijerph18179019

Kim, S. (2021, November 2). Korea makes emissions reduction pledges at COP26. *Korea JoongAng Daily.* Retrieved from https://koreajoongangdaily.joins.com/2021/11/02/national/environment/COP26-Moon-Jaein-climate-change/20211102154524400.html

Kotchen, M. J., & Negi, N. K. (2019). Cofinancing in Environment and Development: Evidence from the Global Environment Facility. *The World Bank Economic Review, 33*(1), 41–62. Retrieved from http://lps3.doi.org.libproxy.snu.ac.kr/10.1093/wber/lhw048

Krishna, I. M., Manickman, V., Davergave, N., & Shah, A. (2017). *Environmental Management : Science and Engineering for Industry.* Elsevier Science & Technology. Retrieved from https://ebookcentral.proquest.com/lib/snulibrary-ebooks/detail.action?docID=4790772

Lähteenoja, S., Mont, O., & Neuvonen, A. (2014). Sustainable lifestyles 2050: stakeholder visions, emerging practices and future research. *Journal of Cleaner Production, 63*, 24-32. Retrieved from https://doi.org/10.1016/j.jclepro.2013.09.007

Lee, K. J., & Youn, Y. C. (n.d.). *Reforestation.* Retrieved from K-Developedia: https://www.kdevelopedia.org/Development-Topics/themes/--4

Lorek, S., & Spangenberg, J. H. (2014). Sustainable consumption within a sustainable economy – beyond green growth and green economies. *Journal of Cleaner Production, 63*, 33-44. Retrieved from https://doi.org/10.1016/j.jclepro.2013.08.045

Maneejuk, N., Ratchakom, S., Maneejuk, P., & Yamaka, W. (2020, November 2). Does the Environmental Kuznets Curve Exist? An International Study. *Sustainability, 12*(21). doi:https://doi.org/10.3390/su12219117

Manta, A. G., Florea, N. M., Bădîrcea, R. M., Popescu, J., Cîrciumaru, D., & Doran M. D. (2020, September 19). The Nexus between Carbon Emissions, Energy Use, Economic Growth and Financial Development: Evidence from Central and Eastern European Countries. *Sustainability, 12*(18). doi:https://doi.org/10.3390/su12187747

Martin, M. A., Alcaraz Sendra, O., Bastos, A., Bauer, N., Bertram, C., Bleckner T., . . . Woodcock, J. (2021, October 18). Ten new insights in climate science 2021 – a horizon scan. *Global Sustainability*, 1-39. doi:https://doi.org/10.1017/sus.2021.25

Neculce, D., & Pacheco Urpi, O. (2018). ENVIRONMENT CONSERVATION AND SUSTAINABLE DEVELOPMENT IN COSTA RICA. *Current Trends in Natural Sciences, 7*(13), 221-224. Retrieved from https://natsci.upit.ro/issues/2018/volume-7-issue-13/environment-conservation-and-sustainable-development-in-costa-rica/

Ocean & Climate Platform. (n.d.). *The Ocean, a carbon sink.* Retrieved from Ocean & Climate Platform: https://ocean-climate.org/en/awareness/the-ocean-a-carbon-sink/

OECD. (2000). Frameworks to Measure Sustainable Development: An OECD Expert Workshop. Paris, France. Retrieved from http://lps3.doi.org.libproxy.snu.ac.kr/10.1787/9789264180635-en

OECD. (2008). *OECD Key Environmental Indicators.* Paris, France: OECD Environment Directorate. Retrieved from https://www.oecd.org/env/indicators-modelling-outlooks/37551205.pdf

OECD. (2014). *Green Growth Indicators 2014.* OECD Green Growth Studies. Retrieved April 2021, from https://doi.org/10.1787/9789264202030-en

OECD. (2020). How's Life in Costa Rica? Retrieved from https://www.oecd.org/statistics/Better-Life-Initiative-country-note-Costa-

Rica.pdf
OECD. (2020). *Income Inequality.* Retrieved from OECD Data: https://data.oecd.org/inequality/income-inequality.htm
OECD. (2020). OECD Economic Surveys: Costa Rica. Retrieved from https://www.oecd.org/economy/surveys/costa-rica-2020-OECD-economic-survey-overview.pdf
OECD. (2020). OECD Economic Surveys: Korea 2020. Retrieved from https://www.oecd-ilibrary.org/economics/oecd-economic-surveys-korea_19990707
OECD. (2020). *Population*. Retrieved from OECD Data: https://data.oecd.org/pop/population.htm
OECD. (2020). *Poverty Rate.* Retrieved from OECD Data: https://data.oecd.org/inequality/poverty-rate.htm
OECD. (2021). Assessing the Economic Impacts of Environmental Policies. *OECD Green Talks LIVE.* Retrieved from https://www.oecd.org/environment/assessing-the-economic-impacts-of-environmental-policies-bf2fb156-en.htm
OECD. (2021, May 25). OECD welcomes Costa Rica as its 38th Member. Retrieved from https://www.oecd.org/costarica/oecd-welcomes-costa-rica-as-its-38th-member.htm
ONF. (2020). *Programa de Pago por Servicios Ambientales.* Retrieved from Oficina Nacional Forestal: https://onfcr.org/psa-2
Pfaff, A., & Robalino, J. (2013, August). Ecopayments and Deforestation in Costa Rica: A Nationwide Analysis of PSA's Initial Years. *Land Economics 89*(3), 432-448. Retrieved from https://www.jstor.org/stable/24243718
Presidencia de la República de Costa Rica. (2019). *Centro Nacional de Control de Energía (CENCE)*. Recuperado de Presidencia de la República de Costa Rica: https://www.presidencia.go.cr/comunicados/tag/centro-nacional-de-control-de-energia-cence/
Préstamo Gil, F., & Zúñiga Gamboa, J. (2020). Análisis de políticas y estrategias implementadas en Costa Rica para el desarrollo sostenible en los sectores monetario, de producción y consumo. *Revista Universidad y Sociedad*. Obtenido de https://www.scienceopen.com/document?vid=17429fb9-9566-4985-ba80-132375e8d523
Ranocchia, C., & Lambertini, L. (2021). Porter Hypothesis vs Pollution Haven Hypothesis: Can There Be Environmental Policies Getting Two Eggs in

One Basket? *Environmental and Resource Economics, 78*, 177-199. Retrieved from https://primoapac01.hosted.exlibrisgroup.com/permalink/f/gpkqdp/TN_cdi_springer_journals_10_1007_s10640_020_00533_x

Sadik-Zada, E. R., & Ferrari, M. (2020, May). Environmental Policy Stringency, Technical Progress and Pollution Haven Hypothesis. *Sustainability, 12*(9). doi:https://doi.org/10.3390/su12093880

Sarkodie, S. A., & Strezov, V. (2018, November 10). Empirical study of the Environmental Kuznets curve and Environmental Sustainability curve hypothesis for Australia, China, Ghana and USA. *Journal of Cleaner Production, 201*, 98-110. doi:https://doi.org/10.1016/j.jclepro.2018.08.039

SEDAC. (2021). *Environmental Performance Index (EPI)*. Retrieved from SEDAC https://sedac.ciesin.columbia.edu/data/collection/epi/sets/browse

Shafik, N. (1994). Economic Development and Environmental Quality: An Econometric Analysis. *Oxford Economic Papers, 46*(Supplement_1), 757–773. Retrieved from http://lps3.doi.org.libproxy.snu.ac.kr/10.1093/oep/46.Supplement_1.757

Singhania, M., & Saini, N. (2021). Demystifying pollution haven hypothesis: Role of FDI. *Journal of Business Research, 123*, 516-528 doi:http://lps3.doi.org.libproxy.snu.ac.kr/10.1016/j.jbusres.2020.10.007

Song, A. Y. (2021). Linking trade and environment in emerging economies: Korea's ambition for making green free trade agreements. *Pacific Review, 34*(2), 321-350. Retrieved from http://lps3.doi.org.libproxy.snu.ac.kr/10.1080/09512748.2019.1672771

The Earthshot Prize. (2021, October). *Protect and Restore Nature Winner*. Retrieved from The Earthshot Prize: https://earthshotprize.org/london-2021/the-earthshot-prize-winners-finalists/nature/

The Economist. (2018). *The World Economy: Biggest Economies Ranking* . Retrieved from The Economist: World in Figures: https://worldinfigures.com/rankings/topic/8

U.S. DOL Bureau of International Labor Affairs. (2020). *Child Labor and Forced Labor Reports: Costa Rica.* Retrieved from US Department of Labor https://www.dol.gov/agencies/ilab/resources/reports/child-labor/costa-rica

UK COP26. (2021, November 04). *END OF COAL IN SIGHT AT COP26*. Retrieved from UK COP26: https://ukcop26.org/end-of-coal-in-sight-at-cop26/

UNDP. (n.d.). *What are the Sustainable Development Goals?* Retrieved from UNDP: https://www.undp.org/sustainable-development-goals

UNFCCC. (n.d.). *Nationally Determined Contributions (NDCs).* Retrieved April 2021, from United Nations Climate Change: https://unfccc.int/process-and-meetings/the-paris-agreement/nationally-determined-contributions-ndcs/nationally-determined-contributions-ndcs

UNFCCC. (n.d.). *The Paris Agreement.* Retrieved from UNFCC: https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement

Vladislav, K. (2013). The Implementation of Green Growth Policy in Korea: context, performance, and future. Retrieved from https://s-space.snu.ac.kr/bitstream/10371/130325/1/000000012486.pdf

Walker, K., & Wan, F. (2014). The Harm of Symbolic Actions and Green-Washing: Corporate Actions and Communications on Environmental Performance and Their Financial Implications. *Journal of Business Ethics, 109*(2), 227-242. Retrieved October 2021, from https://www.jstor.org/stable/23259314

Wendling, Z. A., Emerson, J. W., de Sherbing, A., Esty, D. C., Hoving, K., Ospina, C. D., . . . Schulman, D. (2020). *2020 Environmental Performance Index.* Yale Center for Environmental Law & Policy. Retrieved from https://epi.yale.edu/downloads/epi2020report20210112.pdf

WIPO. (2021). *Global Innovation Index 2021: Republic of Korea.* Retrieved from WIPO: https://www.wipo.int/edocs/pubdocs/en/wipo_pub_gii_2021/kr.pdf

Yacob, P., Wong, L. S., & Khor, S. C. (2019). An empirical investigation of green initiatives and environmental sustainability for manufacturing SMEs. *Journal of Manufacturing Technology Management, 30*(1), 2-25. Retrieved April 2021, from http://lps3.doi.org.libproxy.snu.ac.kr/10.1108/JMTM-08-2017-0153

Zugravu-Soilita, N. (2018). The impact of trade in environmental goods on pollution: what are we learning from the transition economies' experience? *Environmental Economics and Policy Studies, 20*, 785–827. Retrieved from https://doi.org/10.1007/s10018-018-0215-z

7. 초록

이 논문의 목표는 환경의 질과 경제 개발 및 무역과의 관계를 보다 포괄적으로 분석함으로써 녹색 경제를 위한 변화를 유도하는 것이다. 지속 가능한 개발은 성장과 복지에 대한 전통적인 이해에 도전하는 새로운 발전 개념이다. 그 이유는 바로 우리는 한 사회로서 국제 경제 구조뿐만 아니라 모든 세계 시민의 마음에도 변화를 추구해야 하기 때문이다.

교육은 개발을 위한 무한한 가능성을 열어주는 열쇠이다. 그래서 CO_2와 같은 악화에 초점을 맞춘 환경 대책을 활용하는 대신, 본 연구는 환경성과지수(EPI)를 활용한다. 이는 환경 품질이 보다 포괄적이고 다양한 척도가 될 수 있다. 이러한 이유로, 1990-2020년 기간 동안 약 153개국의 패널 데이터로 간단한 선형 회귀 분석을 실행해 왔다.

경제 성장 대책은 너무 복잡하고 불충분한 것이다 그렇기에 더 다양하고 지속 가능한 개발 개념으로 우리의 모델은 기존의 경제 성장보다 더욱 복합적인 환경 측정과 함께 교육과 인구 밀도 같은 사회적 지표를 사용해야 할 것이다. 이 논리의 이면에는 인간의 성장과 발전이 자연자본에 미치는 영향에 대한 우리를 이해하고 심화시키기 위한 것이다.

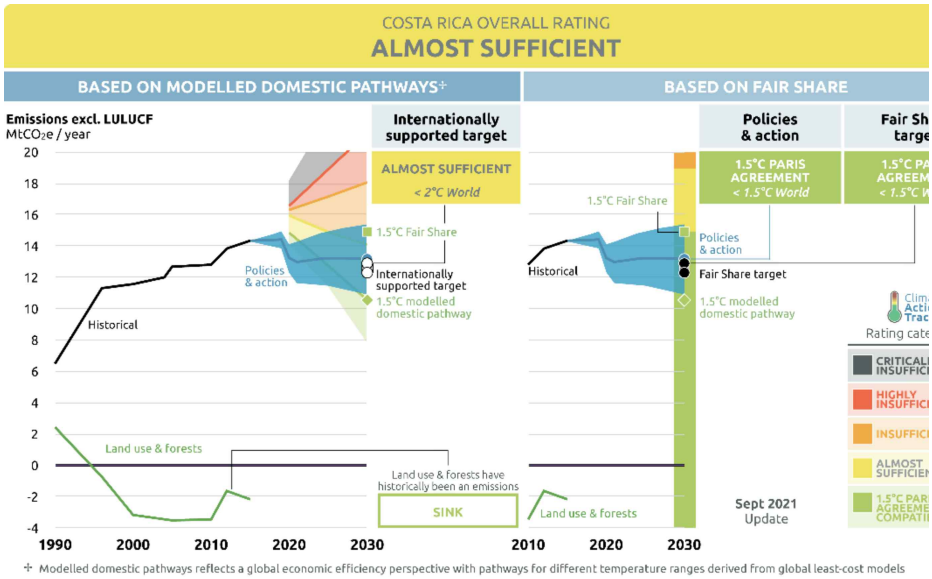
게다가, 우리는 코스타리카와 한국 같은 두 개의 특별한 경제, 즉 보다 지속 가능한 방법으로 경제를 발전시키기 위해 상당한 노력을 기울인 것으로 알려진 코스타리카와 경제 개발의 기적인 나라 한국이 어떻게 그들의 자연자본에 영향을 끼쳤는지도 분석할 것이다. 우리는 그들이 선택한 개발 전략을 고려할 때, 관련 환경 대책에 있어서 양국의 현재 상태뿐만 아니라 그들의 역사적 동향도 살펴볼 것이다.

이 국가들의 분석으로 우리에게 환경적 요인이 경제 정책 결정과

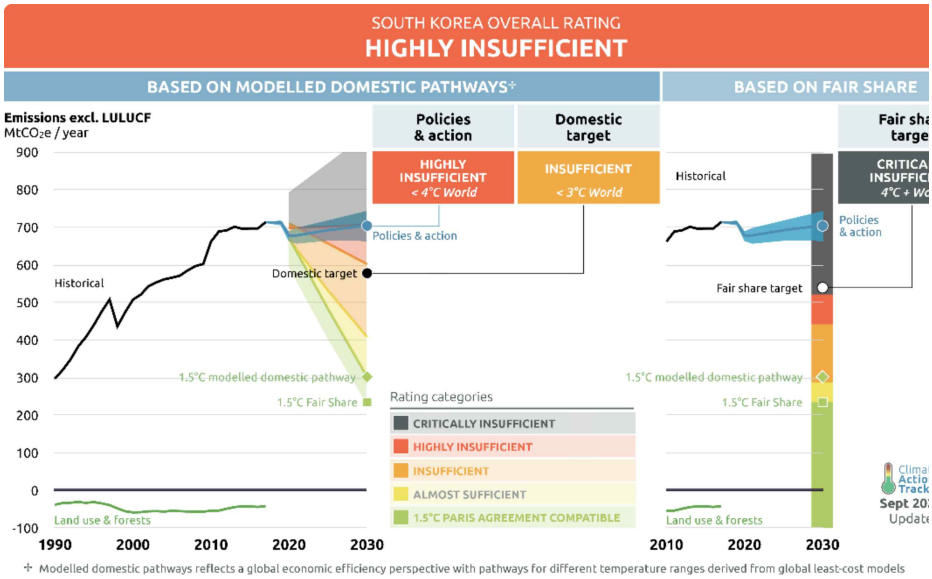
어떻게 상호작용할 수 있는지와 미래에 어떤 것이 최선의 길이 될 수 있는지에 대한 더 나은 아이디어를 줄 수 있다. 그렇기에, 파리 협정과 같은 국제적인 노력이 주기적인 평가뿐만 아니라 기후 변화 위기에 관한 더 큰 타협에 영향을 미쳤다는 것을 기억하는 것이 중요하다 그래서 2015년과 사후 년도에 대한 더미 변수는 만약 그것이 영향이 있었는지에 관해 평가할 의도로 우리의 모델에 추가될 것이고 그 이후로 통계적으로 유의미한 변화를 가져올 것이다.

8. Annex

Annex 1. Costa Rica's CAT Environmental Policies Overview

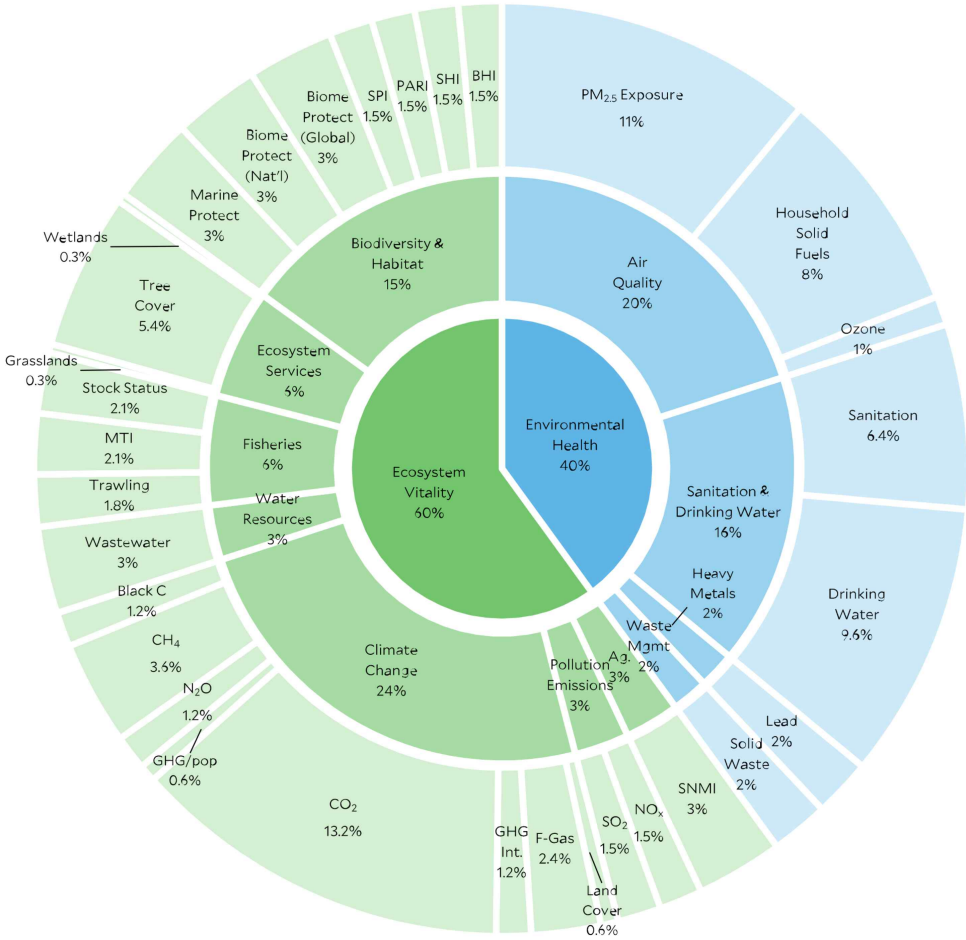


Annex 2. South Korea's CAT Environmental Overview



oth graphs were taken from the Climate Action Tracker website: https://climateactiontracker.org/.

Annex 3. 2020 EPI Framework[40]

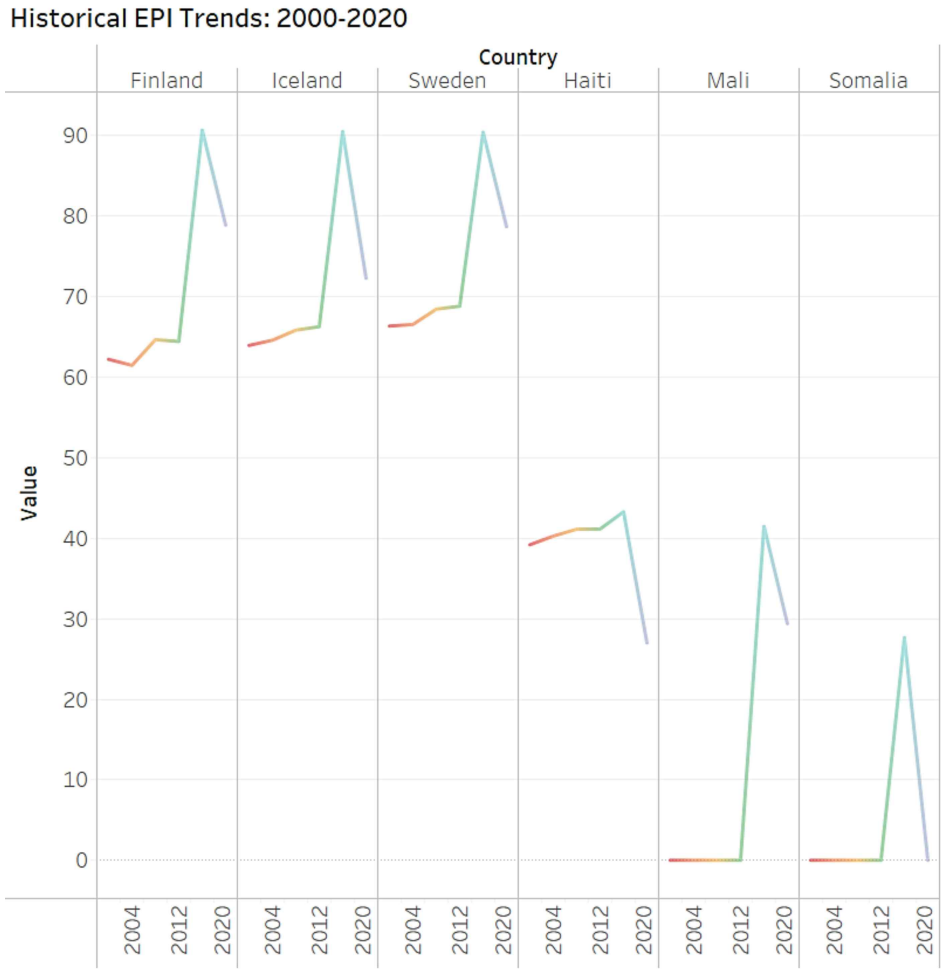


[40] As seen in the 2020 EPI Report.

Annex 4. 2016 EPI Framework[41]

[41] As seen in the 2016 EPI Report.

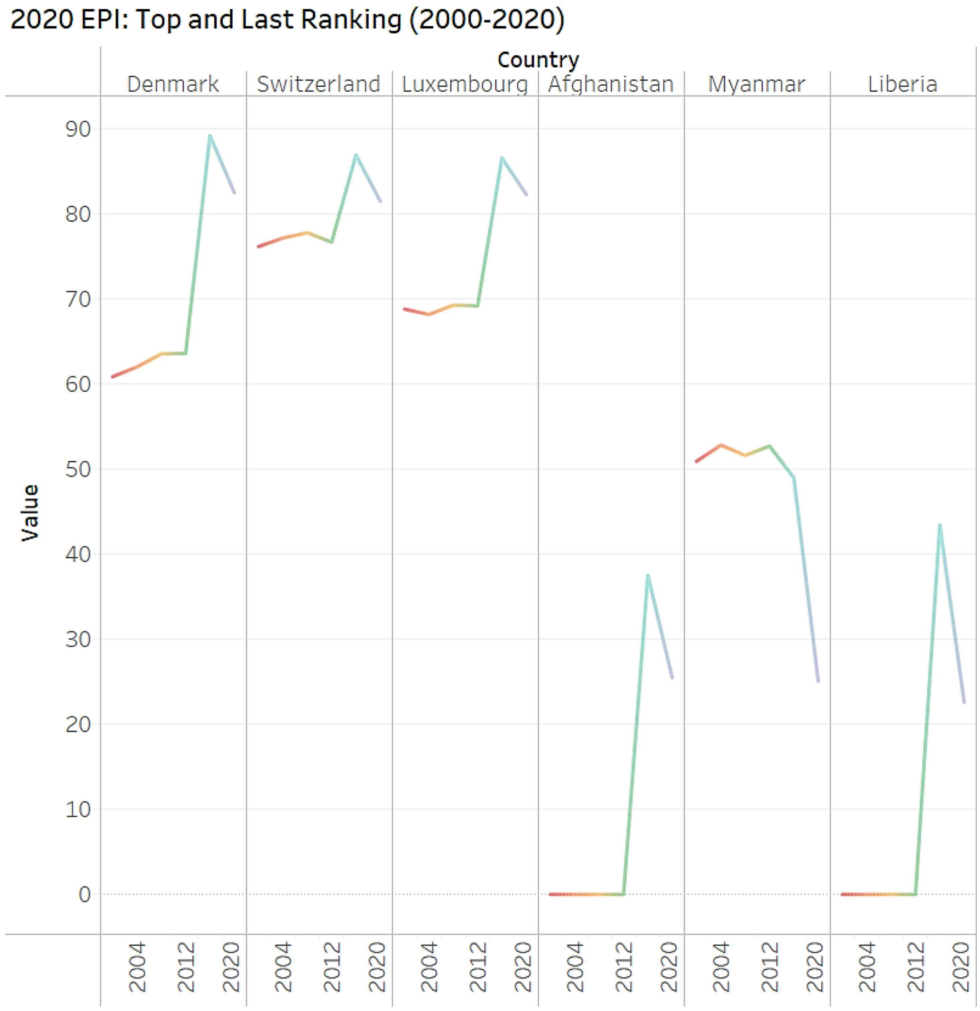
Annex 5. Historical EPI Trends[42]



The trends of 2000, 2004, 2008, 2012, 2016 and 2020 for Country. Color shows details about 2000, 2004, 2008, 2012, 2016 and 2020. The view is filtered on Country, which keeps 6 members.

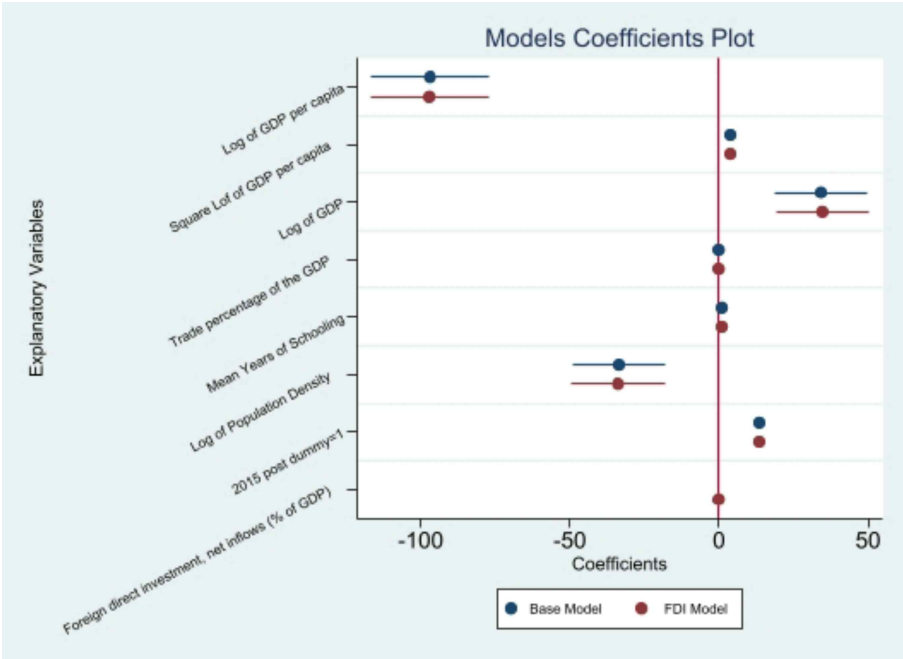
[42] Own preparation with data from the archives of EPI and the 2020 data.

Annex 6. 2020 EPI Best and Worst Ranking Trends[43]



[43] For Afghanistan and Liberia there was no data available in the early stages that is why the trend here shows zero. Own preparation with data from the archives of EPI and the 2020 data.

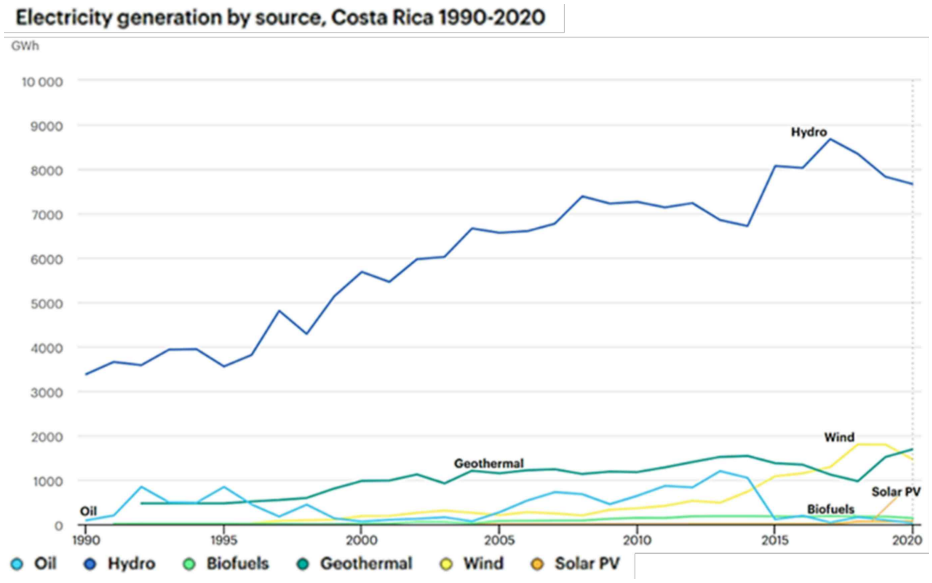
Annex 7. Coefficients Plot: Base vs. FDI Model



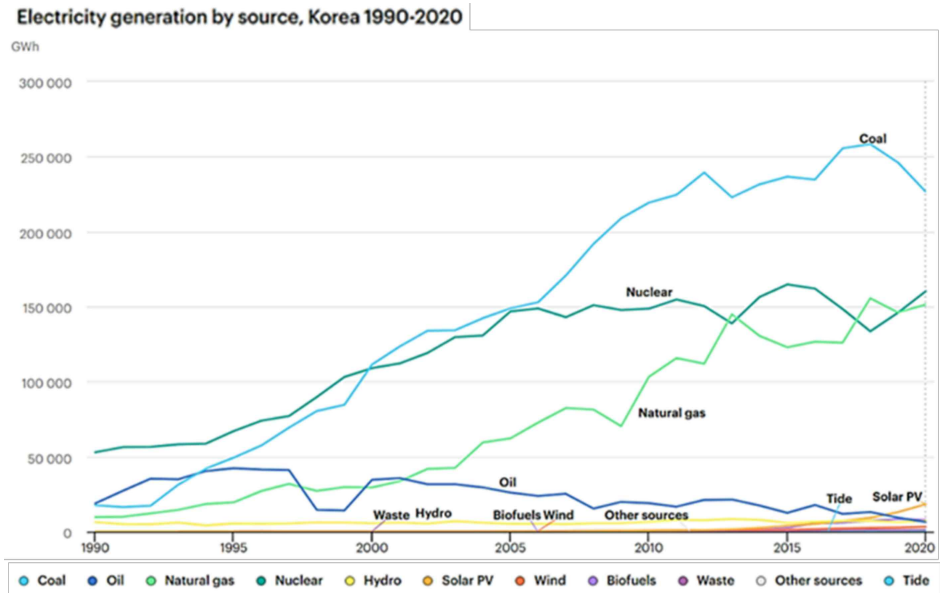
Annex.8. Predicted (ŷ) and Residuals Table

Costa Rica					*South Korea*			
EPI	Base Model		FDI Model		**EPI**	Base Model		FDI M
	ŷ	Residual	ŷ	residual		ŷ	residual	ŷ
65.9619	-2.5245	68.4864	-3.34057	69.30248	52.15335	30.16561	21.98774	29.72033
66.69805	-2.48472	69.18277	-3.28548	69.98354	52.58821	30.79876	21.78946	30.36168
68.36656	-2.39251	70.75907	-3.19975	71.56632	53.26799	31.88707	21.38092	31.44784
68.53317	-2.31739	70.85056	-3.13494	71.66811	54.2036	32.45892	21.74468	32.01349
69.32506	-2.13663	71.4617	-2.97557	72.30064	54.67056	33.31863	21.35193	32.85088
69.0201	-1.95342	70.97353	-2.82054	71.84065	56.03918	33.95668	22.0825	33.48829
68.64723	-1.60561	70.25284	-2.48616	71.13339	56.28623	34.55904	21.72719	34.08413
68.42636	-1.0125	69.43886	-1.90045	70.32681	56.53851	35.4363	21.10221	34.9503
68.63357	-0.48174	69.11531	-1.36171	69.99528	57.19108	36.19126	20.99982	35.6795
69.02813	-0.76981	69.79794	-1.59675	70.62488	57.07095	35.66079	21.41015	35.14799
69.02813	-0.61016	69.63829	-1.44188	70.47001	57.2028	37.04005	20.16275	36.51973
69.03	0.086187	68.94381	-0.75812	69.78812	57.2	38.30009	18.89991	37.76541
58.53	0.666093	57.86391	-0.17957	58.70958	63.79	39.25132	24.53868	38.72631
80.03	14.44576	65.58424	13.54914	66.48086	70.61	53.57362	17.03638	52.99468
67.85	14.93701	52.91299	14.03315	53.81685				

Annex 9. Costa Rica Electricity Generation by Source



Annex 10. South Korea Electricity Generation by Source



Source: International Energy Agency country profiles.