Master's Thesis of Public Administration

What Determines Green Growth in Developing Countries?

The Case of Latin America

개발도상국의 녹색성장을 결정하는 요인에 관한 연구

라틴 아메리카 사례를 중심으로

February 2023

Graduate School of Public Administration
Seoul National University
Global Public Administration Major

María Verónica Velandia Revelo

What Determines Green Growth in Developing Countries?
The Case of Latin America

Academic Advisor Koo, Min Gyo

Submitting a master's thesis of Public Administration

October 2022

Graduate School of Public Administration
Seoul National University
Global Public Administration Major

María Verónica Velandia Revelo

Confirming the master's thesis written by
María Verónica Velandia Revelo

December 2022

Chair	**Lee, Soo-young**	**(Seal)**
Vice Chair	**Rhee, Jeansoo**	**(Seal)**
Examiner	**Koo, Mingyo**	**(Seal)**

Abstract

What Determines Green Growth in Developing Countries?

The Case of Latin America

María Verónica Velandia Revelo
Global Public Administration Major
The Graduate School of Public Administration
Seoul National University

Abstract

Developing countries are particularly vulnerable to the impacts of climate change and resource depletion, Latin America is not an exception. These tendencies will have significant economic, social and environmental consequences, therefore the relationship between environment and the economy should be studied further. A green growth pathway represents an innovative approach that can hence the conservation of the natural capital as well as promote new income sources that are in line with sustainability.

Most of the empirical literature has referred to the EKC hypothesis in order to address these issues. Different from other studies, where the relationship between income and environmental pollution indicators is analyzed, this study followed the literature of the modified EKC replacing the pollution-related dependent variable with a macroeconomic sustainable indicator, namely green growth (through the green growth index), and testes its relationship with income (GDP per capita), in order to construct a sustainable development-guided framework.

Furthermore, the study adds variables that have been identified as determinant factors that positively influence green growth, according to previous literature and empirical studies focusing in developing countries, these variables are: innovation, consumption of renewable energies, and environmental policies. In order to assess the role of the State, two more variables were added, namely government effectiveness and quality of institutions, due to its important role in public administration and for the development of a country.

The hypotheses of the study are that economic growth is one of the most important determinants that is needed to generate green growth, however not alone, innovation (mostly as an effect of the implementation of environmental policies) plays a crucial role in influencing green growth directly. The results of the panel regression with a random one-way effect and a lagged dependent variable, in order to ensure the significance of the independent variables, confirm the hypotheses. A positive and significant correlation between income and innovation towards green growth, with a 90% confidence level was observed. The other control variables, besides the consumption of renewable energy, present a positive relationship with green growth, however not significant as it was expected.

The findings of the study constitute a contribution particularly for the context of Latin America and its policy formulation at the national level, promoting mechanisms for enhancing R&D; at the international level, increasing cooperation in order to promote good practices aiming to enhance the development of green growth, securing the protection of the environment and generating new eco-friendly income sources.

Keywords: Green growth – Latin America – Determinants - Environmental Kuznets Curve – Modified Environmental Kuznets Curve - Sustainable Development – Panel regression

Student ID: 2021-25065

Table of Contents

List of figures

List of Tables

Chapter 1. Introduction

1.1 Background

It is a reality that countries face critical environmental and economic challenges, especially developing economies. In only 5 years the world's consumption of raw materials has nearly quadrupled[1] and only 9% of this is reused, meaning that by 2021 the global economy is consuming 70% more than what the Earth can replenish, which implies severe biodiversity losses and big waste of materials (World Economic Forum, 2022). If no actions are taken Green Gas House Emissions (GHGs) will reach 65 billion in 2030, with an increase of 3 to 6 Celsius degrees in temperature (World Economic Forum, 2022). This scenario will increase climate change effects as floodings, heatwaves and diminish biodiversity, which holds balance of natural systems, to irreversible levels where vulnerable populations are the most affected (OECD, 2018).

Despite this scenario, the global environmental actions that focused in the reduction of climate effects, mainly determined in the Paris Agreement and the Sustainable Development Goals are not achieving their goals. The fact that the countries need to continue growing economically is conflicting, particularly considering the argument that developed economies have grown at expenses of the environment, whereas now developing economies should consider it as a critical issue, not following the logic of "grow now and clean

[1] Reaching more than 100bn tones according to the Circularity Gap Report from the World Economic Forum (2021).

later", assumption that could be misleading and cause serious economic and environmental consequences (Solar and Del Niehaus, 2014).

In this context, it is imperative to analyze the links between environment and economy, and continue studying about how to implement a sustainable grow model that can be effective for poor and emerging economies. Furthermore, the current world trends are delineated by the rapid increment of technology and innovation. For the countries that are initiating to move towards the transition to sustainable growth and whose comparative advantage are the natural resources, as in Latin America, technology and innovation need to be considered as crucial in the planification of strategic policies, that will enable them to be prepared to face economic and environmental adversities.

In this frame, the notion of green growth is located in the middle of the economy-environment debate as a propose to make viable the connection between sustainability and development, in order to growth without risking the future of next generations. Moreover, when talking about green growth, especially in the context of developed economies, technology and innovation play an important role, together with the governmental factor regarding designing and implementing efficient environmental policies (Dugbesan, et al., 2021; Piacentini, 2012). Furthermore, according to the OECD (2013) in the long-term green growth policies can increase wellbeing in the society, by improving resource management and boosting productivity in the areas of best advantage to the society over the long term, leading to innovation to meet new standards.

Even though Latin America is a region that still relies on fossil fuels as an income source, with countries such as Brazil, Mexico, Colombia, Venezuela and Ecuador[2] as the leading countries in crude oil production, and whose whole transport infrastructure is totally made for fossil fuel cars, facing an abrupt transition to green energy is almost impossible, however, the world trends are showing that the green revolution is certainly going to happen and therefore is desirable that all the countries despite of their economic classification, should start taking the green transition seriously. For these reasons, it is imperative to firstly identify what are the determinants that positively influence green growth in the context of the Latin American countries, in order to assess the feasibility to increase green growth, which will lead to specific policy strategies.

In this regard, initiatives taken about the possibility to grow in a green way, respond to a double purpose: first, be aware and conscious of the current environmental situation and take actions to mitigate climate change and global warming effects, and second to generate transformation in industry. However, it is rational to think that in order for the countries to care about the environment and green technologies, firstly basic needs should have been covered. This aspect is explained by the Environmental Kuznets Curve (EKC),

[2] In 2021, Brazil produced 2.9 million oil barrels daily, the largest producer in Latin America. Mexico was second with 1.7 million barrels, Colombia produced 0.7 million and Venezuela was fourth with 0.5 million (however it has the largest oil reserves in the region by far). Ecuador reached 0.4 million (Statista, 2022).

which is a theoretical relationship between environmental degradation indicators and income per capita. The theory implies that until a certain threshold of development is reached, at which point, increases in income per-capita (due to economic development) will generate a better relationship with the environment; hence, before that threshold is reached economic growth will lead to environmental damage (Ekins, 1997) . This infers that a certain point of economic development is needed in order for countries to start taking care of the environment.

According to some body of the literature, the EKC is one of the most popular and studied hypothesis that represents the relationship between growth and quality of the environment (Mishra, 2020), implying sustainable growth. In general terms, proponents of the classical EKC hypothesis argue that when higher levels of economic development take place, the quality of the environment decreases, until a certain point when, due to the effects of technology, the country will increase its environmental quality while increasing its income at the same time (Stern, 2015). This relationship shows an inverted-U shape. However, findings regarding the EKC have not been conclusive, especially when comparing among developed and developing countries.

Furthermore, the majority of studies about EKC are motivated mainly by the environmental issue, and not as an input to address new ways of development. Considering the current economic system that is motivated by constant and infinite growth and maximization of utilities, the environmental perspective is not enough motivation to transit towards sustainable development for the short term, where the countries need to maintain income sources to survive, specially in the developing countries context.

In this regard, according to the Green Growth Institute, green growth as a development model can sustain strong economic growth, while boosting innovative environmental sustainability and opportunities, that will bring poverty reduction and social inclusion in the long run; while at the same time reducing the collateral effects of climate change. Deepen in the study of green growth and its determinants are crucial, as a development generator for the region, considering its comparative advantage.

1.2 Statement of the Problem

The world is moving towards a green tide due to the effects of climate change, the increasing scarcity of natural resources, and the provision of food security. However, countries need to continue growing and maximizing their income sources. Therefore, there is a need to look for sustainable development paths, that not only protect the environment, but continue generating growth. These new paths are specially marked by green energies, technology and innovation, that also generate new industries. However, in developing countries, the situation is even more complicated since the majority of their economies them depend on primary goods exports and there are low levels of innovation and technologies as it is the case of Latin

America. Even though, some levels of green growth have been generated as the Green Growth Index shows.

The EKC hypothesizes that an inverted U-shaped relationship exists between indicators of environmental degradation and economic growth with different indicators (pollution, CO_2 emissions, deforestation, energy among others), meaning that there is a positive correlation between growth and pollution, until a certain point, when the last one starts decreasing while GDP continues growing (Hassan et al., 2020; Bhattarai and Hamming, 2001). In this sense, the notion of growing economically in a sustainable way (sustainable growth) would be confirmed through the existence of the EKC. However, the majority of the EKC studies have been based in developed countries. Therefore, despite the importance of these findings, studies have shown different results regarding the existence of the curve in developing countries, where for Latin America no particular study was found. Moreover, beyond the potential of the green growth concept, there is not enough empirical research about the factors that influence it, in order to purpose appropriate policies.

Therefore, the present study aims to contribute to the clarification of the existence of EKC in Latin America taking the Green Growth Index (GGI) as an indicator of greening the economy and therefore improving the quality of the environment. According to the literature (Ahmad et al., 2021; Tawiah et. al., 2021; Olivares and Hernandez, 2020; OECD, 2013; 2011) the factors that are mostly related to the provision of green growth are growth, innovation and environmental policies (the role of the State). In this regard the pursue of green growth involves not only growing economically and protecting the environment, but also fostering innovation and addressing strategic policies to generate new opportunities around sustainable technologies in the future, while at the same time reducing the risks of degradation of natural resources and the threats of climate change.

In this framework, there is a need for international collaboration among developed and developing countries in order to foster and achieve a transition to green economy and sustainability.

1.3 Significance and Purpose of the Study

The lack of awareness regarding the effect that environmental and innovation policies can have in generating sustainable development, translated into green growth, is the main reason of this study. It aims to raise the attention of the governments that the survival of more than half of the economically active population in the developing world directly depends, in whole or part, on the environment, through agriculture, fishing, forestry or even tourism (Todaro and Smith, 2012), reason why it’s smart and sustainable utilization is crucial.

In Latin America, natural resources represent the main productive sector contributing to foreign exchange earnings (Meller, 2020), however the rich natural resources also situate the region in a particularly vulnerable position due to the impacts of climate change (Studer, 2019). Within the most important effect of it are the scarcity and pollution of water resources, the loss of biodiversity, and the degradation of ecosystems versus food demands, posing a huge risk to the world, specially to the most vulnerable populations (Mishra, 2020; OECD, 2018).

In this context, a transformation of sustainability and economic growth is needed not only to prevent environmental disasters, but also to preserve non-renewable resources and at the same time generate new sources of income, in accordance with the environment. Latin America is not an exemption. The region needs to grow economically according to the new world tendencies, and this includes prominently the role of technology and innovation, in an increasingly context where higher efficiency in resource use and lower carbon footprint can be a source of global competitiveness (Piacentini, 2012).

Furthermore, according to Meller (2020) there is evidence that natural resources can lead to set the foundations for knowledge development and technological innovation, due to production linkages between capital goods and consumer or manufactured goods. This process will give rise to new productive activities that promote development, even though they are related to the primary sector, it will foster economic and social inclusion in Latin America. Therefore, the importance of preserving the natural resources, while continue taking advantage of them is an essential factor for development.

The concept of green growth appears as a promising tool that combines these two aspects, being a potential solution for the economic and environmental dilemma, which is inherent to the sustainable development theories. Determining the factors that positively influence green growth in the particular context of the Latin American region is an initial path to the elaboration of key environmental and industrial policies aiming for an efficient transition to sustainable development, which reaffirms the government as a crucial actor.

In this context, the purpose of the study is to identify the main determinants that positively influence green growth in the context of Latin America, in order to focus on the factors that should be considered for policy design to protect the natural capital, while generating a transition to new income sources that are in line with sustainability.

This objective is important from the understanding that developing countries, in this case Latin American, need to look for twofold alternatives: increment of economic development and protection of the environment; the las one appears as an international commitment but also as a responsibility to conserve one of their main competitive advantages (their natural resources). The protection, conservation and planned consume of them will maintain and increase income sources as eco-tourism, clean energies, green and fair trade, among others in the mid and long run. This study considers this scenario as the starting point and therefore sees green growth as needed and desired.

However, is it realistic for developing countries to count on green growth as a tool for sustainable development? A complete answer to this question might go beyond the purpose and limits of this research, nevertheless the initial step in order to answer it, is to identify what are the most important determinants that have influenced the increment of green growth in Latin American countries, which is crucial to: firstly, understand the green growth dynamic in the region, and with it, secondly, plan strategic policies according to the present and future conditions. In this regard, to determine the factors that influence green growth in Latin America, in order to increase it, constitutes the purpose of this research.

In this line, considering that an important body of literature (Dugbesan, et al., 2021; Mishra, 2020; OECD, 2013) has shown that one of the most important factors that influence green growth is GDP, the EKC hypothesis, which represents the relationship between growth and quality of the environment (Bhattarai and Hamming, 2001), is considered. Following more recent literature, the study proposes to test a modified EKC (MEKC), which instead of using pollution indicators, includes sustainability and well-being indicators (Costantini and Martini, 2010, as cited in Farhani et al., 2014); in this study they are addressed through green growth. Furthermore, the study is line with the literature that, beyond the classic EKC model, suggests to add additional variables to complement the model, implying that only economic growth can’t be attributed to increase or reduce the quality of the environment (Barbier and Burgess, 2015).

In this regard, the variables that have mostly explained the variation of green growth in previous studies are included in the model, particularly (but not exclusively) when studying developing countries these variables refer to (besides economic growth): innovation (Piacentini, 2012), environmental policies (Ozusaglam, 2012), and consumption of renewable energy (OECD, 2013). In addition, considering these prominent findings of previous studies, and in the frame of public adminsitration, this study proposes to add variables to assess the role of the government, highlighting that the impact of policies can be significant, especially in the context of Latin America. In this regard, the role of the government is included through two controlled variables: government effectiveness and quality of institutions.

Due to the positive relationship assumed between GDP and green growth, it is expected that the model can explain the variation of green growth through the modified EKC, denoting that economic growth will increase green growth after a certain point, implying that, economic growth is the most important determinant for generating green growth however it is not sufficient. Innovation, mainly from private sector, as a reaction of environmental policies play a crucial role in fostering green growth. Furthermore, renewable energy consumption is assumed to be another important determinant for green growth in Latin America, however do not correspond to the focus of this study because in the majority of Latin American countries renewable energy is based on hydro power, which requires important investments in order to be expanded. Therefore, efforts in new areas are needed in order to shift to the green transformation and generate new income sources, where the role of the government is important, and hence addressed, through the assumption that it can moderate the increment of green growth but do not influence it directly.

In this regard, the study aims to contribute with theoretical and empirical evidences that show the importance of green growth, as a path for developing new sources of income and protecting the natural capital, and the effect that addressing environmental and innovation policies can have in order to foster it.

In this regard, the EKC hypothesis has represented the model applied in the studies addressing sustainability as one of the most important policy goals (Farhani et al., 2014). Prominently, scholars have tested the curve within the context of developed countries, or comparing them towards and between developing countries (Ding et al., 2021; Al-mulali et al., 2015; Bhattarai and Hamming, 2001). However, despite of the important contributions that these studies have made, the diversity of results present a significant challenge. In this regard, the OECD (2013) has shed light in the importance of distinguishing between developed and developing countries, where no study that focuses in Latin America particularly has been found.

Furthermore, the present research follows goes beyond the classic model of the EKC, complying with the logic of more recent literature that refers to a modified EKC (MEKC), which instead of using pollution indicators, includes sustainability and well-being indicators (Costantini and Martini, 2010, as cited in Farhani et al., 2014), in this study represented by green growth.

1.4 Plan of the Study

In the first chapter of the study, the introductory part was addressed, including the background, statement of the problem, significance and purpose of research. From this background, the second chapter covers the theoretical framework and literature review that constitute the fundaments of the thesis, where sustainable development theories and EKC studies are highlighted.

Chapter 3 refers to the Research Design, including analytical framework, research question, hypotheses, method and methodological steps that were conducted through the process and the corresponding explanations of it. Chapter 4 includes the results of the model and the discussion of them, according to policy implication. Finally, Chapter 5 addresses the conclusions and limitations of the study, according to the theoretical approach, research question and hypotheses, and includes recommendations for policy design and further studies.

Chapter 2: Theoretical Background and Literature Review

2.1 Sustainable Development Theories

The concept and theory of sustainable development evolved from the development theory of W. Rostow, appearing in his book *"The Stages of Economic Growth"* that was published in 1960. It argued that economic growth had "well-defined stages, starting with traditional society through development takeoff, economic maturity, and high consumption". According to his theory the countries should focus first in the development of agriculture and industry. In the late 1970s other scholars advocated a focus on basic needs, including education, sanitation, health care, employment (Mishra, 2020:12).

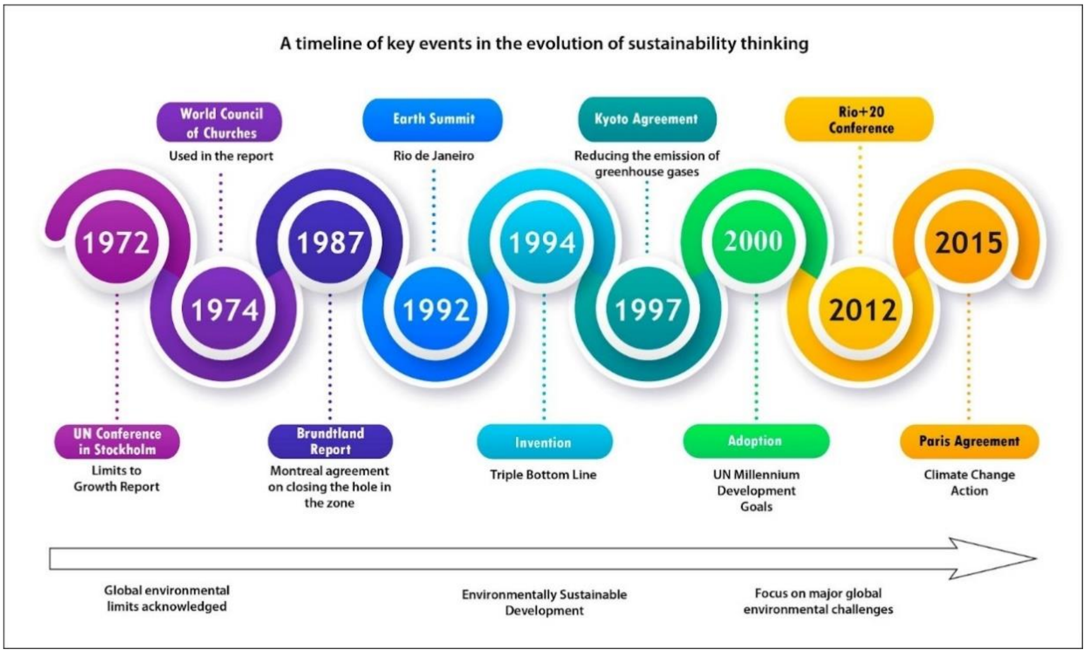
In this context, sustainable development emerged according to the following three most important features: 1) from the economic perspective, it provides goods and services in an equitable and continuing basis to all citizens, regardless of their country. 2) According to the environmental perspective, it doesn't allow non-renewable resources to be reduced and the excessive exploitation of renewable resources. It should ensure the maintenance of biodiversity and clear watersheds. 3) the social aspect refers to the sustainability and balance between rich and poor, in a frame of adequate social services, gender equality, political accountability and participation (Mishra, 2020). In this regard, sustainable development does not focus on the environment solely, but it conceives it as the basis for the integral development of the society, denoting the need of balance between economic growth and environmental preservation.

In the international political spectrum, Brundtland Report in 1987 was the turning point that boosted sustainable development. It defined sustainability as “meeting the needs of the present generation without compromising the needs of future generations” (World Commission on Environment and Development, 1987, as cited in Todaro and Smith, 2012:467), since according to classic definitions a development path is sustainable if the stock of the overall capital remains constant or rises over time (Pearce and Warford, 1993, as cited in Todaro and Smith, 2012). However, these conceptions present a huge challenge for the world economic model, which depends on extractive practices in order to maintain an infinite economic growth with finite natural resources.

In the 1980s, the progress in science and technology took place and reduced the pessimistic considerations about the environment. Economists introduced the theory of “endogenous growth theory” that assumes that technological development is a continuous progress stemming from innovations made in firms, that can be supported by the governments to develop new eco-friendly technological devices remedying environmental problems (Grossman and Helpman, 1991; Lucas 1988 and Romer 1986, as cited in Özcan and Öztürk, 2019).

In this context, and since the publication of the Brundtland report the UN took the lead in framing global dimensions for sustainability, together with several international initiatives, they have reached agreements pursuing sustainable development, being aware that the preservation of natural resources and a sustained growth require joint efforts, not only from the environmental activists, but also from political and economic actors (Axelrod and VanDeveer, 2014), at three levels: micro (individuals), meso (institutions) and macro (countries). Figure 1 shows the most remarkable events within the evolution of sustainable development in the international thinking:

Figure 1 Timeline of key Aspects in the Evolution of Sustainable Development



Adapted form: Axelrod and VanDeveer, 2014

One of the most important international commitments that were achieved in the frame of the UN were the Millennium Development Goals

(MDGs) as an outcome document of the Rio+20 Conference: *Our Common Future*. According to the progress that was made in this commitment and considering the critical challenges remaining, in 2015 the United Nations Member States committed on the document *Transforming our World: the 2030 Agenda for Sustainable Development*, which is the frame of the 16 Sustainable Development Goals (SDGs) aiming to positioning not only the achievement of economic development but the inclusion of social aspects, with an environmental basis and consciousness.

In this regard, it is clear that sustainable development doesn’t exclude economic growth, in fact it is at its core. Promoting growing but in a sustainable way will lead to the improvement of the environmental quality and social inclusion. Therefore, sustainable development represents the context of green growth (Mishra, 2020), as it could be inferred from the definition of the green growth theory: “Green growth theory asserts that continued economic expansion is compatible with our planet’s ecology, as technological change and substitution will allow us to decouple GDP growth from resource use and carbon emissions” and continues “this claim is now assumed in national and international policy, including in the Sustainable Development Goals” (Hickel and Kallis, 2019).

However, to absolute decouple GDP from the use of resources seems something impossible to achieve at the moment, still green growth is a possible way to contain the current and prospect severe environmental damages, extremely necessary at the moment, taking into account that according to the OECD (2018) due to certain amount of climate change already locked in, some extreme weather events are projected to become more severe, namely extreme heat or food insecurity, even if international climate goals are met. In this regard, the concept of green growth has emerged as an increasingly dominant response to the challenges that climate change is producing. It has been gaining importance in the environmental governance and policy strategies due to its innovative agenda, centered on the transformation of industries to revise the existing development model (Mishra, 2020).

Some literature indicates that the theory behind green growth is that economic expansion or economic growth can be compatible with the environment (Hickel and Kallis, 2019), considering that technological change will positively affect decoupling GDP growth from resources use and CO2 emissions. This argument has been put into practice at national and international levels, through the SDGs framework, considering that it became internationally relevant in the Rio+ Conference (Hickel and Kallis, 2019).

In 2011 the OECD developed a green growth strategy *"Towards Green Growth"*. In the same year the UNEP launched a report titled *"Towards a Green Economy: Pathways to Sustainable Development and Poverty Eradication"*. Whereas in 2012, the World Bank published *"Inclusive Green Growth: The Pathway to Sustainable Development"*. During the Rio+20 Conference these institutions together with the Global Green Growth Institute created the Green Growth Knowledge Platform, as a mechanism to promote green growth strategically around the world. Each of these organizations provides a definition for it (Hickel and Kallis, 2019).

According to the OECD (2011:18, as cited in Hickel and Kallis, 2019:470) green growth refers to “fostering economic growth and development while ensuring that natural assets continue to provide the resources and environmental services on which our well-being relies” and “it is also about fostering investment and innovation which will underpin sustained growth and give rise to new economic opportunities” as it is complemented in OECD (2010, as cited in Piacentini, 2012). According to the World Bank (2012, as cited in Hickel and Kallis, 2019:470) it is defined as:

> Economic growth that is efficient in its use of natural resources, clean in that it minimizes pollution and environmental impacts, and resilient in that it accounts for natural hazards and the role of environmental management and natural capital in preventing physical disasters.

Furthermore, to achieve greener growth strategies are needed, they should consider new ways of producing and consuming things, where non-technological and innovation such as business models and city planning, including transportation, will be useful in driving green growth, and also constantly revise the process of how to measure it (Mishra, 2020).

In this frame, the OECD has developed the “Environmentally adjusted multifactor productivity growth”[3] which reflects the core of green growth.

---

[3] More about this indicator will be explained in the following section.

However, this indicator is mainly available for the OECD members and in a shorter period of time. Whereas, in the materialization of green growth as concept and macro indicator the Global Green Growth Institute (GGGI), in partnership with several international governmental and non-governmental institutions and governments[4], developed the Green Growth Index (GGI) and published it for the first time in 2019, and its trends have been developed since then for previous years, reaching 2006[5]. It covers 115 countries of different regions of the world.

> The GGI is a composite index measuring a country's performance in achieving sustainability targets including Sustainable Development Goals (SDGs), Paris Climate Agreement, and Aichi Biodiversity Targets for four green growth dimensions – efficient and sustainable resource use, natural capital protection, green economic opportunities, and social inclusion (Acosta et al., 2019a, as cited in Global Green Growth Institute, 2020).

The GGI is designed to track green growth performance in four dimensions of green growth, and it is the first index to benchmark green growth performance against the targets of the international agreements (SDGs, Paris Agreement and Aichi biodiversity targets). It gives the countries the chance to track on how well they are doing to become green, and how much

---

[4] World Bank Group, UNDP, UN-WOMEN, International Labor Organization, Food and Agriculture Organization, Organization of Eastern Caribbean States

[5] This information was obtained through a non-structured interview with the representants of the GGI, in charge of developing the index.

more needs to be done, while there are significant opportunities to improve their performance and become greener (GGGI, 2022).

In this regard, the concept of green growth derives from a combination of an economic and sustainable view of the environment, which consists of natural resources that, in economic terms, are viewed as natural capital (Okoh, et al., 2018). It refers to a green transformation through sustainability, where the last one doesn’t mean that natural resources should be left untouched. Instead, it should consider the intergenerational equity, balancing the resource distribution between present and future generations. This implies that the present consumption should ensure that the non-renewable resources contribute in the long-run to economic and social health of the population; whereas for renewable resources its consumption should be aware and coordinated with the natural productivity, considering time and mode resources grow (Okoh, et al., 2018).

Moreover, the importance of preserving the environment lies also in the present income sources, rather than only in the survival for the future, since for less developed and developing countries, natural resources are considered to be the bowl for the transition to middle or upper middle countries (Okoh, et al., 2018).

This subsection has shown sustainable development is inherited in the concept of green growth. Hence, sustainable development can be reflected through green growth, even though the first one can have a broader approach, generally[6]. Furthermore, derived from the need of environmental care and the need of growth, concepts like green economy and green growth have been developed in the international institutional framework and have been specially connected to the achievement of SDGs. Therefore, next section elaborates in the relation and differences among them.

2.1.1 Green Growth, SDGs and Green Economy

The concepts of green growth, sustainable development and green economy are interconnected; however, they have particular differences. For some scholars and civil society organizations, this interconnection can also lead to a lack of clarity and distinction between them (green growth, green economy, and sustainable development) (UNDESA, 2022). In fact, some other scholars consider that "Due to the shared goal, namely preserving sufficient natural resources for future generations, green growth, green economy and sustainable development are sometimes regarded to be the same in practice" (Statistics Netherlands, 2013:4). Furthermore, according to some scholars (Hickel and Kallis, 2019; Smulders et al., 2014, as cited in Hickel and Kallis, 2019), despite the three definitions provided in the previous section, still the concept of green growth appears blurry and not precise.

Therefore, in the present section a detailed clarification is made, in order to 1) distinguish between the concepts, 2) Show why the study focuses

[6] This would vary according the operationalization of green growth; however, some measures have been evolving towards a more inclusive perspective that can meet the SDG theoretical framework, especially regarding the Green Growth index from the Global Green Growth Institute that in the last years has included social dimensions. This index is explained in sub-section *2.4 Green Growth in Latin America*.

in green growth and 3) Confirm that even though there is a distinction between these concepts at its core they are intrinsically connected.

It can be said that the international significance of green growth started in the Rio+20 Conference on Sustainable Development in 2012[7], which simultaneously promoted a green economy to achieve a sustained economic growth, hence the link between these three concepts is prominent. In fact, the three major proponents of the green growth theory in the international sphere that reported about it in the Conference are: the OECD, the United Nations Environment Program (UNEP) and the World Bank (Hickel and Kallis, 2019).

In this regard, the OECD provides one of the most elaborated conceptual frameworks for green growth and green economy in the frame of SDG:

Difference between green growth and sustainable development

The main difference between green growth, as well as green economy, is that both are considered as a tool to achieve sustainable development, represented in the SDGs. Green growth focuses mainly in the nexus between environment and economy, therefore provides more detail on environmental resource productivity. According to the OECD, "Green Growth means fostering economic growth and development, while ensuring that natural assets continue to provide the resources and environmental services on which our well-being relies" (OECD, 2022). It mainly addresses green policy

[7] Since then, green growth has become an increasingly important response to warnings about climate change (Hickel and Kallis, 2019).

indicators and economic opportunities that might arise for 'greening growth'. On its part, sustainable development covers broader policy indicators, including investments and productivities with environmental perspective, but also aspects related to society and culture (OECD, 2011, as cited in Statistics Netherlands, 2013:1).

However, as innovation and technology advances in order to face contemporary challenges, concepts and frameworks evolve parallelly. The concept of green growth has been changing in the last years too. According to the Global Green Growth Institute (GGGI)[8], green growth is the pursuit of economic development in an environmentally sustainable manner. In developing the Green Growth Index (GGI) policy makers, GGI Member Countries and members of the international expert groups have joint efforts to develop a useful tool for policy makers. The GGI started to be elaborated in 2019, and its trends have been developed since 2005 (Global Green Growth Institute, 2020).

In respond to the COVID-19 pandemic in the Technical Report of 2020 the GGGI included enough indicators to measure performance towards SDGs and inclusive growth, in light of the COVID-19 recovery. The GGI conceptual framework is composed by 4 pillars: 1) Efficient and sustainable

[8] The Global Green Growth Institute (GGGI) is a treaty-based international, inter-governmental organization founded in 2012 at the Rio+20 Conference. It is dedicated to supporting and promoting strong, inclusive and sustainable economic growth in developing countries and emerging economies. It was founded in order that economic growth and environmental sustainability should be integrated as essential for the future of humankind. GGGI works with developing countries to put green growth at the heart of their economic planning: https://gggi.org/about/

resource, 2) Green economic Opportunities, 3) Natural Capital Protection and 4) Social Inclusion (Global Green Growth Institute, 2020).

Difference between green growth and green economy

The UNEP defines green economy as the one that results in “improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcities” (UNEP, 2020). Previously, the same international organization had defined it as one that “simultaneously grows income and improves human well-being ‘while significantly reducing environmental risks and ecological scarcities’” (UNEP 2011:16, as cited in Hickel and Kallis, 2019:470), which shows the innovative aspects of the terminology in this field, due to the constant evolution of it. However, at the Rio+20 Conference, green economy was recognized as a tool to achieve sustainable, social, economic and environmental development, and according to a relevant source, in essence, “a green economy is low-carbon, resource efficient and socially inclusive” (Statistics Netherlands, 2013:4).

Moreover, in a green economy, income and employment are driven by public and private investments that reduce carbon emissions and pollution, enhance energy and resource efficiency, and prevent the loss of biodiversity and ecosystem services. The main difference between green growth, that is mainly leaded by the OECDE, and green economy is that in the last one, the UNEP prominently includes the social dimension by directing efforts specifically to poverty reduction and social equity (Statistics Netherlands, 2013). However, as it was showed previously, in the last year the green growth index included the social dimension on its conceptual framework, providing a useful tool for further studies and policy making.

In general, as mentioned by Capasso, et al. (2019) green economy, can or not be related to growth (some papers study the *greening* in relation to a no-growth or shrinking economy), and sustainable development on its part is also differentiated since it includes other conditions for growth rather than green growth. Consequently, green growth is more focused on the relationship between economy and environment, and including social aspects recently, that are considered in the GGI, which makes this index an operationalizable updated tool with enough years of study (since 2005, however in this study is considered since 2006 due to the other indicators availability).

Regarding other useful indicators to measure green growth, the "Environmentally adjusted multifactor productivity growth", represents the definition and measurement of Green Growth according to the OECD. However, this indicator does not cover many Latin American countries, since it is focused on the OECD members, and provides a shorter period of time in comparison to the GGI. Regarding indicators for green economy, the UNEP is still developing an appropriate indicator. Therefore, there is no other index related to green growth (or green economy) that represents to the best extent the core of green growth and that covers that as many years and countries.

2.1.2 Environmental Kuznets Curve

The Environmental Kuznets Curve (EKC) appears as one of the most popular theories, explaining the relationship between growth and quality of environment (Mishra, 2020). In the background, the origin of Kuznets curve came from Kuznets's explanation about the relationship between income and inequalities, in 1955. Subsequently, the first Kuznets curve related to the environment was produced by Grossman and Krueger in 1991, as part of a study of the potential environmental impacts[9] of NAFTA (North American Free Trade Agreement), considering the relationship between economic growth versus pollution (Hassan et al., 2020).

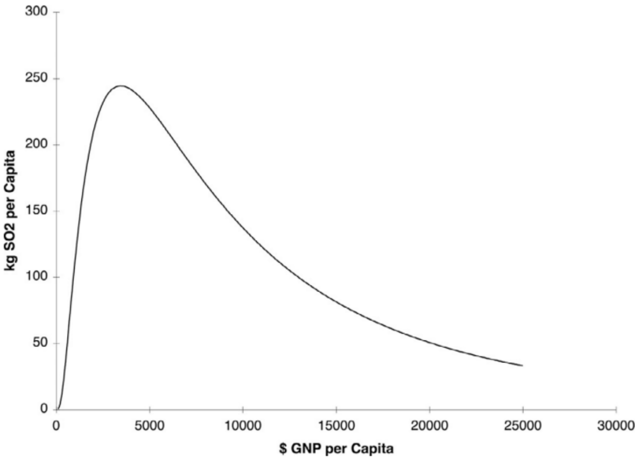
The EKC was popularized by the World Bank's 1992 World Development Report, arguing that the idea of damage that the expansive economic activity can cause to the environment doesn't consider the dynamism of technology; and that as income increases, demands for improving the quality of environment will increase as well (Stern, 2015).

The EKC hypothesis explains the relationship between economic activity, normally represented by income per capita, and indicators of environmental degradation, and it has been the dominant theory explaining this relationship (Mishra, 2020). It argues that there is an inverse relationship between pollution emissions and environmental quality, as a characteristic of the early stages of economic growth; namely that when the first one increases the second one declines.

[9] They estimated EKC s for SO2, dark matter (fine smoke), and suspended particles (SPM) using the GEMS dataset.

However, beyond some level of income per capita (which will vary for different indicators) the trend will change to the point that the increment of economic activity (income per capita), will lead to environmental improvement. This indicates that the emissions per capita (or other environmental impacts) are an inverted U-shaped function of income per-capita (Stern, 2015). Figure 2 shows an estimated EKC, where the turning point indicates that when approximately USD 5.000 GNP per-capita are reached emissions per capita start to decrease:

Figure 2 Estimated Environmental Kuznets Curve



Source: Panayotou (1993) and Stern et al. (1996), as cited in Stern, 2015.

However, the polluting emissions do not disappear. Literature has asserted the importance of considering that the reduction of the emissions can be exported from developed to developing countries, transferring industries overseas, or developing countries itself start to increase their productive activity, which leads to the increment of emissions. Therefore, it can be concluded that the EKC is in essence an empirical phenomenon that has been tested in different sceneries, however its findings are not conclusive, especially when comparing between developed and developing countries.

According to a study by Hassan et al. (2020) that analyzed the relationship between CO2 emissions and GDP, using a panel data approach with 64 developed and developing countries from 1970 to 2015, the results showed that in the case of GDP an inverted U shape relationship was confirmed, suggesting the possibility of actual green growth. In this regard, significant evidence of global environmental Kuznets curve was found for both economies[10]; while an increment in developing countries' GDP shows more pollution, at the same time they are expected to revert faster towards green growth in comparison to developed countries (Hassan et al., 2020). This might be possibly as an effect of the rapid expansion of technology.

In the same line, some evidence shows that in high-income countries a particular innovation is expected to be adopted before than in the majority of poorer countries, however, over time emissions may be declining at the same time in low- and high-income countries, hence the particular innovation taken could be different in the different countries. Moreover, this finding suggests that structural input and output factors can play a role in modifying the scale effect of rising income in per capita emissions. This would mean that in slower-growing economies technological change can overcome the scale effect (Stern, 2015), which is the point that this study aims to dig in more.

[10] Conclusions were founded in the evidence that in the long run increase in the energy use intensity and the global integration lead to increase of CO2 emissions.

The study of Ahmad et al. (2021) was applied to 11 developing economies, finding supportive evidence to the inverse U-shaped linkage in the long run. This indicates that the rise in real GDP per capita plus electricity consumption provides a combination to mitigate emissions of carbon-dioxide in the long run for the whole sample of countries. However, when looking specifically to each country, the results suggested the presence of EKC for some countries[11], that could be grouped as emerging economies. whereas for another group[12], in general terms considered less economic developed, the EKC was not proved.

The conclusion of this study is that the countries of the last group need to design strategic policies to reduce pollution (measured in carbon dioxide emissions) from economic activity and electricity generation through effective renewable sources. Finally, the paper states a crucial argument regarding that bidirectional causal links were observed among the variables, and therefore recommends that in order to increase environmental sustainability in developing countries, specific action plans should be designed and implemented according to each country's context (Ahmad et al., 2021).

In the same context, Olivares and Hernández (2021) demonstrated through a systematic review that not only growth is enough to stop environmental degradation. For example, there are countries with high deforestation rates and high income per-capita. As well as poor countries that

[11] Brazil, China, India, Malaysia, the Russian Federation, Thailand, and Turkey.
[12] Mexico, Philippines, Indonesia, and South Africa.

with good environmental policies achieve better environmental results than rich economies. Moreover, emerging and developed economies (like China, India, Russia and USA) are still responsible for the majority of the global CO2 emissions, which contradicts the hypothesis.

Nevertheless, still the majority of research that have studied EKC has been focused in the developed economies, with more 80% of the literature according to a study done by Sarkodie and Strezov in 2019 (as cited in Olivares and Hernandez, 2021). Through the same study 4 research sublines were identified: In the first one, the concave form was explained (inverted U) and goes from 1991 to 1998 (these are called first order determinants). In the second one, other factors were included beyond GDP per-capita. These are called second order determinants (1997-2020). The third one refers to literature that criticizes the hypothesis (includes Arrow in 1995 and Stern in 2017). The 4th one refers to econometric models between environment and growth (Olivares and Hernández:2021).

In the first order determinants, it is assumed that the rise of GDP will involve higher levels of technology and improvement in public policies, crucial to explain why the increment in GDP will not damage the environment. However, this assumption would imply that solely focusing in increasing GDP would be the solution for the environmental damage, nevertheless according to some scholars there is conclusive evidence about an EKC that applies only to few pollutants, showing that EKC literature can’t be taken to imply that economic growth on its own will foster environmental improvement (Barbier and Burgess, 2015). In this regard, in the second order, other variables are incorporated directly, beyond the logic of only income per-capita. This inclusion can change the form of the curve.

Regarding the critics that have been attributed to the EKC, according to Mishra (2020) based on empirical studies including Dasgupta and others (2002), the EKC was challenged by the idea that the curve will raise until a horizontal line, which denotes maximum pollution levels, in comparison to the more optimistic critique which suggests that the curve drops and shifts to the left as growth generates less pollution in the first stages of industrialization and pollutions begins falling at lower income levels. However, there is not enough empirical evidence supporting these two schools of thought. Some other critics have argued that developed countries have become clean partially exporting their dirty production to poorer countries, meaning that the current less developed economies will not be able to replicate fully this experience.

According to these critiques the present considering considers to key aspects, the first one is that it is possible to agree that minimum levels of income are required to start generating positive effects towards the environment, namely green growth. This notion provides the idea that economic growth is one of the main determinants of green growth, which is an aspect that will be proven in this study. However, some evidence has suggested that focusing solely on economic growth to deliver positive environmental outcomes can be counter-productive (Everett, et al., 2010).

Secondly, even if the current developing countries can’t be able to replicate the successful experience of developed countries, green growth is still an innovative tool that, besides addressing climate change effects, could guide the green path to other successful aspects involving innovation, better policies, coupling the role of the government with the private sector. Therefore, analyzing their determinants is relevant.

Furthermore, there are indirect aspects that relate the economic activities and environmental degradation, especially when considering trade, since it will increase economic growth, which in turn will help to protect the environment through raised incomes. However, for this to occur, sustainable use of energy is a key requirement (Mishra, 2020). Therefore, the consumption of renewable energy is an aspect considered in this study, even though not as its main focus, since Latin American countries clean-energy production is boosted by an abundance of hydropower, being the main renewable source (De la Hoz, 2021; Our World in Data, 2021; The Economist, 2016), which requires high levels of investment and is not a booster for competition among the private sector. Therefore, it is considered mainly a controlled variable in order to determine what other aspects influence green growth in the region.

This subsection covered the basic aspects regarding the EKC, the following subsection will refer to previous studies regarding green growth and EKC.

2.2 Green Growth and EKC: Previous Studies

Some scholars have defined green growth as the "continued economic expansion (as measured by Gross Domestic Product") that can be compatible to our planet's ecology" (Hickel and Kallis, 2019:469), which is the argument that has been defended from the sustainable development field. At its core, green growth indicates whether economic growth is becoming greener with more efficient use of natural capital (OECD,2020). It represents the possibility that countries have to grow in a sustainable way, which belongs to the bigger theoretical framework, considering not only economic but also social factors, like inclusion (included in the GGI OF 2020), inherent to human beings. It is important to acknowledge that on light of the current phenomena (environmental, economic and social crisis, where politics play a crucial role) not only economic aspects are to be considered when talking about "growth".

In this regard, one of the most important theories that has studied the relationship between growth and environment refers to the Environmental Kuznets Curve, where the role of sustainability (and not only the environmental degradation) has represented main steps in the last years (Farhani et al., 2014). According to this, countries start to pay attention to the environment after certain basic needs have been covered (Oeycan, B. and

Oeyturk, I. , 2019), and this occurs when a certain level of economic growth has been achieved, implying that to increase the quality of the environment (which is an essential part of green growth), firstly economic growth is needed. From the literature reviewed and presented so far, it is possible to infer two important aspects according to the goal of this research in relation to the EKC in the context of developing countries: 1) The most relevant variables that stand out are: innovation, energy sources and the role of the government (policies), 2) The presence of the EKC differs between countries and the analyzed factors. The tendency shows that the presence of the curve mostly depends on the indicator that is being tested (indicating the environmental degradation) (Selden and Song, 1994: 155, as cited in Olivares and Hernandez, 2021). In developed or emergent economies, the presence of EKC has been more commonly proven, whereas in developing countries it highly varies. As expressed by the same authors, EKC results are partial results of larger and more complex contexts, that could lead to inaccurate interpretations, but also those econometric studies are useful tools and inputs for policy makers to analyze and understand to what elements does the presence of absence of the curve respond. Especially useful are the panel data analysis.

In respect of studies that have analyzed the EKC specifically in the Latin American and Caribbean context, Al-mulali, et al. (2015), confirmed the EKC hypothesis, implementing CO2 and GDP data. Furthermore, they included variables as renewable energy (RE) and financial development (FD) in the model and found that RE does not contribute to CO_2 reduction in the long run and that there is causality between GDP, RE, FD and CO_2, in short and long run, meaning that these factors could be a good solution to reduce environmental damage (due to its causal effect on CO_2). Finally, the research showed that the countries should increase their banking loans on green energy, energy efficiency and energy saving projects in order to reduce environmental damage (Al-mulali et al., 2015:918).

Furthermore, important body of the literature has shown that the motivation behind the study of EKC and green growth is mostly related to environmental conservation, rather than the promotion of new ways of economic development. This is a rational approach considering that "increasing environmental degradation became one of the major issues that the world is facing" as expressed by Al-mulali, et al. (2015:918). However, within the real context countries might be more inclined to develop towards a greening economy if they see positive results on its income coffers, rather than only being motivated by the conservation of the environment.

Subsequently, three main agreements in the literature were found: 1) There is a strong positive correlation between green growth and growth, as one of its main influences or causes. 2) Innovation and public policies play an important role in increasing green growth. 3) The determinants that influence green growth differ between developing and developed countries. These ideas are going to be referred and expanded in the next subsection.

In the same sense, according to the literature whose focus has been green growth, GDP appears as one of the first determinants to influence it (OECD, 2013;2018), considering that green growth is at the end growth by itself. In these studies, in order to control the influence of population when comparing countries with different sizes, GDP per-capita is used (Dugbesan, et al., 2021). In conclusion, it could be inferred that EKC hypothesis model can be used to identify the determinants that influence green growth in Latin America.

Furthermore, regarding the implementation of policies for green growth, it will involve a paradigm shift in the way public policies for economic growth are conceived. It requires coordination at all levels of governance, calling for a better integration of policies, where economic growth and higher environmental quality are mutually supportive (Piacentini, 2012). For this purpose, multiple policy instruments are required to be combined. Ideally, policy makers should pursue an integral policy package, taking into account aspects like how firms can adjust to new business opportunities, how individuals change their preferences, and how technologies are developed to be integrated in the market. Within Piacentini (2012) key policy package recommendations are included: support for increasing the eco-efficiency of industrial production, support for research and innovative applications of green technologies. Therefore, the role of the government is crucial.

2.3 Green Growth Determinants: Between Developed and Developing Countries

By focusing on green growth, the attention is draw to factors that facilitate efficient and effective use of resources (moving beyond the traditional carbon emission focus) to achieve economic development and sustainability. However, some studies have found that this process differs between developing and developed countries. For instance, the document *"Determinants for green growth in developed and developing countries*" (2020), based on a sample size of 89 developing countries and 34 developed countries (hence, developing countries drive the main results) found that countries at different development levels will require different strategies in order to achieve the SDGS, hence green growth (Tawiah et al., 2021).

Economic growth (GDP)

Regarding the determinants that were found on the economic side, economic development was found positive and significantly associated with developed countries but insignificant for developing countries. "This contrasting result suggests that developing countries that are growing fast are over-utilizing their natural assets, but developed countries experiencing fast economic growth are efficient in managing their natural assets towards green growth" (Tawiah et al., 2021:4). The authors explain that developed countries incorporate efficient technical process in their growth. However, it is relevant to consider that developing countries can have fundamental differences in terms of economy (and policy efficiency).

Therefore, even though this study provides crucial findings, with the recognition that there are different determinants for green growth according to the economic level of the countries, this is not enough to understand the particular situation of a region, even less of a country, since developing countries as a whole is still a broad category to formulate specific policies; reason why the present study aims to provide a more precise perspective including only Latin American countries and find the green growth determinants according to this more specific context[13].

According to a study conducted by Dugbesan, et al. (2021) aiming to model the determinant factors of green growth in the MENA (Middle East and North African) countries using data from 1990-2019. The findings showed that foreign direct investment, renewable energy, institutional quality, and GDP per capita are the main factors that promote green growth. On the other side, population has a negative effect in these countries, which could be the case of other countries as well. Therefore, in empirical models studying green growth population is controlled through the use of GDP per-capita.

[13] According to other international economic aspects, the cited study argues that developing countries have to pay attention to foreign direct investment and the trade they engage in to avoid harming the environment. Whereas this doesn't affect green growth performance in developed countries. However, this aspect is not considered in the empirical study due to the fact that the Latin American economy heavily relies on international trade, specially inter-regional (74.2% of the trade is made with other regions of the world, being North America, Asia and Europe the most prominent destinations. Only the remaining 25.8% of the trade remains within the Latin American region) (World Trade Organization, 2015). Considering this, even if it would be confirmed that trade sources constitute a crucial determinant for green growth in developing regions including Latin America, it would be too difficult and unrealistic to change their trade partners and patterns, considering that trade doesn't depend on governments solely, and is a very sensitive area for these countries as primary products exporters, whose industries are inexistent or they can't compete internationally. Therefore, the generation of green growth should be based on the creation of new income sources, according possible policies and not limiting the existing ones, but generating the conditions to improve them in the near future.

Environmental policies and innovation

This subsection combines environmental policies and innovation due to the important body of literature that addresses the effect that effective environmental policies can have in boosting innovation in the private sector (Mishra, 2020). Starting with the increment of GDP, as the igniting aspect that, specially through policies and innovation, will drive the sustainability of growth, through eco-friendly products and services (Dugbesan, et al., 2021). As expressed by Ozusaglam (2012) besides the conventional technology-pushed and demand-pulled factors, environmental policy has a strong impact on eco-innovation. The argument comes from the Porter hypothesis, which states that stringent and properly designed environmental regulations (e.g. market-based instruments as taxes or cap-and-trade emissions allowances), can foster innovation that in the long run can partially or fully counterbalance the costs of complying with them (Porter and van der Linde 1995, as cited in Ambec et al., 2011). This argument clearly represents the importance of the governmental role, as an actor that can apply environmental measures, with a double purpose: to reduce negative environmental practices and create innovation.

On other side, regarding the approach of the classical EKC, where pollution indicators, such as CO2 emissions, have been typically tested, according to Tawiah et al. (2021) it is more likely that countries with high CO2 emissions have more incentive to engage in green growth due to the inherent obligation of reducing the environmental problem, of which they are the contributors. However, the results suggested that CO_2 emission is less likely to be a significant determinant of green growth based on country classification[14]. On the contrary, considering environmental policies, specially from the tax collection perspective as it has been determined in relevant literature (such as the Manual of EKC by Özcan and Öztürk, 2019), has the potential to project a bigger picture of the environmental quality the potential spillover that will increase the innovative and environmental mindset.

Government efficiency

In view of the fact that environmental policies and innovation are considered as determinant for green growth, the role of the Government as the regulatory actor in charge of developing these policies appears as a key aspect. Policy makers can promote new sources of renewable energy, clean processes and practices that can reduce air pollution, improve waste management, and ultimately increase life standards, through mechanisms as green loans or holidays taxes, which would give leverage to the investors and contribute to the reduction of emissions (influencing green growth). Policies play the key role in improving local and global sustainability, where political commitment and efficiency will subsequently be reflected in green economy and green growth (Mishra, 2020).

[14] Latin American countries are not significant CO_2 distributors, having only 3% of the historical emissions[14], in comparison with Europe with 33% (including Russia, Turkey, Ukraine), North America and Asia with 29% (where China accounts12,7%) and India alone 3% (Our World in Data, 2022).

Politicians can establish green growth strategies, therefore their commitment and efficiency can accelerate the greening the growth path of an economy, depending on policy and institutional settings; which subsequently reflect the level of development, resource endowments and particular environmental pressures within a country. Therefore, beyond the creation of policies, the government performance has an influence in the delivery and effectiveness of them. These action can be measured through the efficiency of the government which will delineate the different challenges and opportunities in greening growth for advanced, emerging, or developing countries. In every case, policy action requires looking across a very wide range of policies, not just traditionally “green” policies (Mishra, 2020), where the indirect action of the government, hence its efficiency has an impact.

Institutional quality

In line with the governmental role, institutional quality, which includes the quality of laws and the strength of enforcement agents, can either promote or retard green growth. A well-established institutional quality promotes economic activities while reducing carbon emissions (indicating an inverse relationship between energy consumption and green growth) (Salman et al. 2019). Quality institutions also ensure that firms are complying with environmental regulations, as asserted by Tawiah et al. (2021). According to the same study, the influence of institutional quality (and energy-related factors) shows similar results for both, developed and developing countries, implying that this factor is different from others, where the economic level plays a role.

However, according to other sources (Özcan and Öztürk, 2019), at final or alter phases of industrialzİation (or post industrial), the increment of the economy leads to environmental improvement, due to demand of the people. People pay more attention to the environment and subsequently the regulatory institutions become more effective. In these countries, where environmental policies are developed, policy makers should ensure that a well-established institutional quality is in place, but not too strict to avoid the trap of being counterproductive to economic growth and development (Dugbesan, et al., 2021). However, this context is not the case of Latin America, where some environmental policies have been applied, but there is still a long path to transit.

According to this analysis, institutional quality might not have a significant influence in green growth, probably not directly, however as a horizontal aspect that is determinant, not only for increasing green growth, but for the governance and development of a country as a whole, this aspect requires attention and further research, therefore should be included in the analysis.

Renewable energy consumption

The conclusion of Tawiah et al. (2021) is expected when affirming that the consumption of renewable energy increases green growth in all countries regardless of whether it is classified as developed or developing. In Latin America, between 25% to 32.8% of the primary energy comes from renewable sources [15], according to OLADE and to HUB-ENERGIA respectively, 59% of the total electricity generation comes from renewable sources, being hydro the principal source of them; it represents 45% of the total electricity supply of the region, surpassing the world media which is 16%, according to the International Energy Agency (2022). Whereas alternative sources of renewable energy, such as solar, wind and geothermal are still incipient with around 2%, in comparison to 6% of the world average (The Economist, 2018).

However, for many environmentalists hydropower doesn't represents a totally clean energy, considering that water is not an unlimited resource and that the construction of hydroelectric involves the destruction of natural environments (J Luis et al, 2013). In addition, hydropower is not isolated from the climate change effects, they pose an increasing challenge for the region which needs to be considered now. Therefore, it appears important to look for other green growth determinants, to identify what other aspects are to be considered to boost it. Based on this idea, the consumption of renewable energy is taken as a control variable in the present study, since its correlation with green growth is proven and in Latin America renewable energy is mainly based on hydro. In general terms, the inclusion of energy consumption

[15] According to the Executive Secretary of the Latin American Organization for Energy (OLADE), this share represents the highest percentage compared to the rest of the world (OLADE, 2020).

appears to be relevant in light of the growing literature on the causal relationship between the quality of the environment and income (Farhani et al., 2014).

As it is possible to observe, literature shows that the role of policies (related to environment), quality of institutions and how efficient are both of them are factors that influence green growth. These aspects are under the control of governments, reason why their role is considered an important aspect. As mentioned by the OECD "good policy can ease the transition to a greener model of growth. Investment in green growth and the implementation of structural reforms to support the transition can sometimes help to boost growth and employment in the short term" (OECD, 2013)

2.4 Green Growth in Latin America

The OECD, World Bank and the Green Growth Institute which are the main international organizations studying green growth (as part of the Green Growth Knowledge Platform[16]), have stated all the difficulties that countries face for fostering green growth particularly in developing countries. In this regard, first it is important to look at the levels and variation of green growth in the Latin American context. Considering that there are few indicators that have tried to measure green growth integrally, the green growth

[16] The Green Growth Knowledge Platform, also called Green Economy Coalition (GEC) works to accelarate the transition to fgreen and fair economies. It includes more than 50 organizations from private, public and international sectors affirming that green economies are possible, neccesary and desirable (Green Policy Platform, 2022).

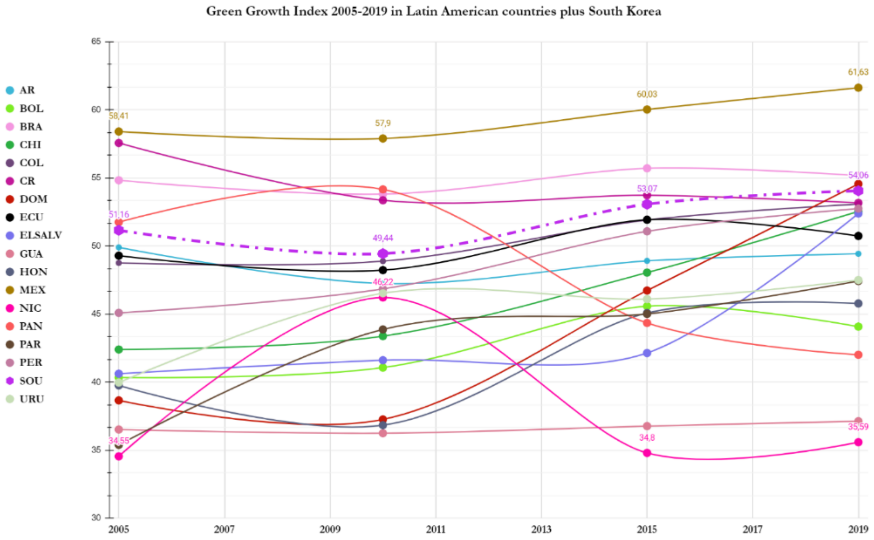
index GGI is one of the most complete, longest and inclusive index (as it was described in subsection 2.2.1).

Data regarding the Green Growth Index exists since 2006 to 2019, for the different regions of the world in the GGGI repository[17]. However, during the years the concept and its measures have been evolving constantly, according to the global trends and findings. Despite the fact that during the years the concept has changed (as it happens with many other indexes), at its core the GGI measures how much the different countries have grown in a sustainable way.

Regarding Latin America, Figure 3 shows the variation of the Green Growth Index in the 17 Latin American countries through the years (2006-2019), according to the Green Growth Index that in the last years has even included a social factor, in addition to the main pillars: natural capital transformation and GDP. It is calculated in a scale of 0 to 100, being 100 the closest to a sustainable growth. South Korea is used a comparison country, it was chosen as a reference because of its transition from developing to developed economy in the last 60 years. In order to distinguish it a dotted line was applied only to this country.

[17] The dataset is possible to find under:
https://ggindex2020.herokuapp.com/SimulationDashBoard/country-profile

Figure 3 Variation of Green Growth Index – Latin American Countries plus



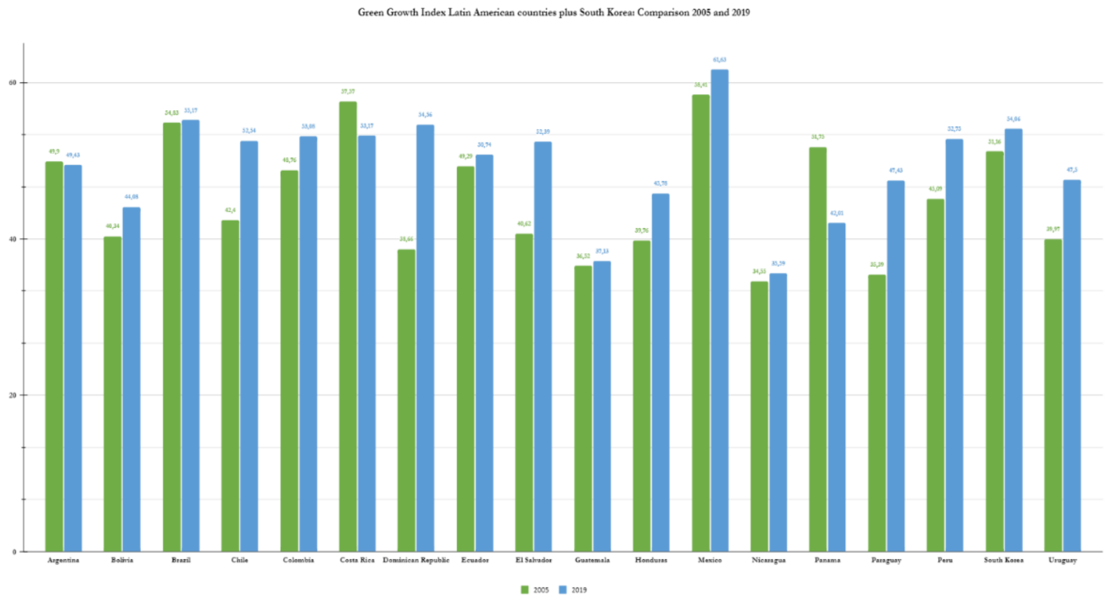
South Korea (2005-2019)

Source: Global Green Growth Institute, 2020
Own elaboration

As it is possible to observe the country that possess the highest GGI is Mexico, which shows a constant and progressive increment, from 58.41 in 2005 to 61.63 in 2019. Whereas Guatemala registers the lowest values and a minimal change, from 34.55 in 2005 to 34.59 in 2019. Regarding the countries that show the most prominent variation, Nicaragua and Panama, having an important rise in the first years until 2010, and then showing an important decrease until 2015. After that year, in the case of Nicaragua it shows a light increase until 2019, whereas Panama persisted decreasing even though not that prominently as in the previous years, the decrement is constant.

In this chart, South Korea (dotted line) is located among the countries with upper middle Green Growth Index, and in general terms shows an increment from 51.16 in 2005 to 54.06 in 2019. Here it is important to consider that the information collected to develop this index is the information that has been reported by the official governmental sources, as it happens with other indexes. Therefore, it stays under discretion how accurate and transparent governments are when reporting the required data. Furthermore, when comparing the variation of green growth between the first and the last years, in 2005 the country with the highest index was Costa Rica, with 57.57, whereas in 2015 Mexico occupies the first place with 61.63. Figure 4 shows this comparison.

Figure 4 Latin American Green Growth Index Comparison between initial and

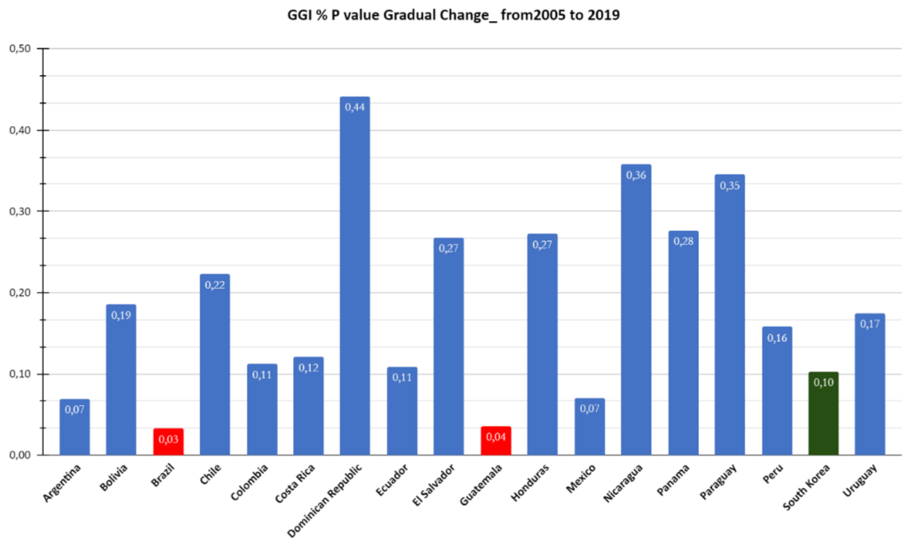


Source: Global Green Growth Institute, 2020
Own elaboration

final Year by Country

Moreover, when analyzing the P value gradual change %, the country that shows the highest increment is Dominican Republic, with 0.44% yearly between 2005 and 2019, followed by Nicaragua with 0.35%. On the other side Brazil and Nicaragua are the countries that have increased the least yearly, with 0.03% and 0.04%, respectively.

Figure 5 Green Growth Percentage P-Value Change in Latin America



Source: Global Green Growth Institute, 2020
Own elaboration

The previous graph confirms the statements of the international organizations pointing out the difficulties to increase green growth. As it is shown, GGI variation in Latin American countries (and even in Korea) has not increased prominently through the years (economic crisis, e.g. in 2008 may play an important role on its development too). Nevertheless, some countries show a better performance than others rising the question about what influences these changes.

Chapter 3: Research Design

3.1 Analytical Framework

The analytical base line of the present study takes contemplates the theoretical postulates that at low levels of income no or insignificant budget is allocated to protect the environment, due to pervasive levels of poverty, ineffective tax collection and lack or low levels of awareness (Özcan and Öztürk, 2019). In this regard, the study considers that economic growth is the igniting aspect that can generate green growth, implying that without a certain value of GDP[18], green growth can't be produced, as it is stated by the sustainable development theories, the endogenous growth theory, with the EKC hypothesis and even the Solow model (Dugbesan, et al., 2021).

In this regard, this study takes the EKC model to proof the existence of the curve, namely the effect of GDP in green growth. In order to represent the EKC model, GDP and its squared form should be added. Despite the fact that some studies have also included a GDP cubic form (Bhattarai, M. and Hammig, M., 2001), which has the purpose to imply that another turn would take place in the EKC once income reaches higher levels, showing further analysis in the EKC research, this refers mostly for countries that are located in a developed phase of industrialization, which do not correspond to the Latin American case, therefore the GDP cubic form is not included.

[18] According to the literature average approximation has referred to USD 5000 GDP per-capita (reference is made in section 2.2, Figure 2).

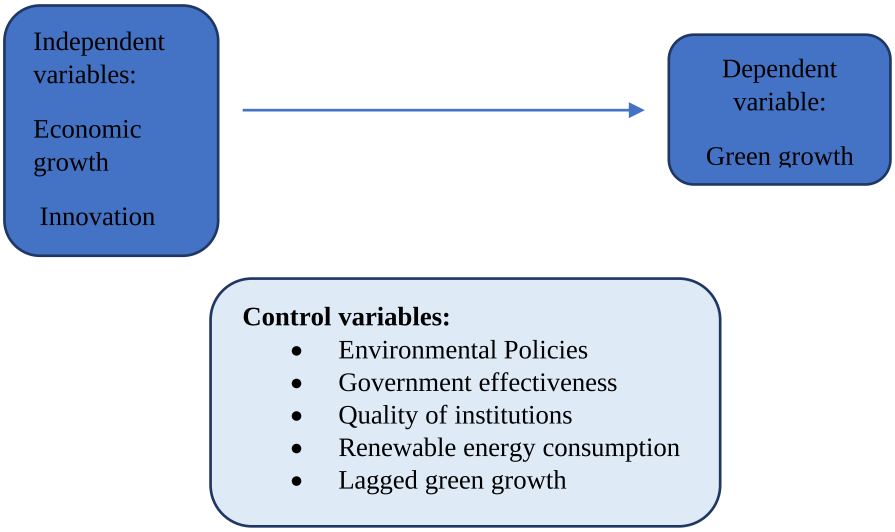
Furthermore, as the second wave of the EKC studies have shown (Olivares and Hernández, 2021), exclusively economic growth is not enough to increase the quality of the environment (Barbier, 2015), especially in developing countries (Hassan et al., 2020). According to empirical literature, innovation and environmental policies are necessary to have positive effects in green growth (Dugbesan, et al., 2021; OECD, 2013 Ozusaglam, 2012; Piacentini, 2012), therefore they are included in the model. However, the hypothesis of the study is that regardless of the environmental policies that can take place within a country, if innovation is not generated, specially from the private sector, green growth is not going to be generated. Hence innovation, is considered as independent variable and environmental policies take a secondary role as a control variable, influencing green growth, however not directly.

Following the same line, the role of the government appears as the igniting actor that can foster policies for innovation and environment, therefore its role is considered as an indirect factor that influences green growth. The main indicators that are included representing the role of the government are government effectiveness and quality of institutions, following previous studies that have included these indicators that can contribute to the efficiency and growth of the economies, and thus influence the relationship between environment and income (Bhattarai, M. and Hammig, M., 2001).

Furthermore, since the majority of Latin American countries do not produce high levels of CO_2 emissions (in comparison to other regions of the world), and considering that their clean energy source is mainly based on hydropower, the renewable energy consumption is added, mostly as controlled factor that influence green growth in numbers, however it doesn't constitute the main focus of the study, which looks forward to identify the green growth determinants beyond the hydropower effects, in the search of new ecofriendly income sources.

Finally, considering the literature discussion in Keele and Kelly (2017) a lagged dependent variable is included in the analysis in order to capture dynamics effects of the model and ensure the significance of the variables.

FIGURE 6 ANALYTICAL FRAMEWORK



3.2 Research Question

According to the literature review one of the most important determinants for improving the quality of the environment, to where green growth belongs to, is economic growth. This leads to the assumption that economic growth is determinant for green growth. This relationship has been tested within different context and indicators through the Environmental Kuznets Curve. However, some literature has shown that economic growth alone can’t be considered as granted to increase green growth, aspects as innovation and environmental policies play an important role. Furthermore, depending on the economic classification of the country, determinants can change too. No empirical study has applied the green growth index in the EKC model particularly in context of Latin America, in order to foster it. Therefore, the following question is proposed:

- What are the main determinants that positively influence green growth in the Latin American context?

3.3 Hypotheses

According to the literature review and the previous framework provided, the following hypotheses are proposed:

H1: There is a significant and positive correlation between income and green growth in the context of Latin America.

H2: There is a significant and positive correlation between innovation and green growth in the context of Latin America.

H3: There is a positive relationship between renewable energy consumption, environmental policies, government effectiveness and quality of institutions and green growth, however it is not significant.

3.4 Research Methodology

3.4.1 Methodological Steps

In order to answer to the proposed research question, the study applied a 3-step methodology:

1) Literature review

Extensive literature search and review of high quality and most recent sources about the prominent aspects that have been considered as determinant in the variation of green growth. In this aspect special attention, but not exclusive, was given to the literature in context of developing countries, particularly of Latin America[19]. In the first literature review more than 150 sources were reviewed, considering: theoretical and empirical approaches, as well as manuals, reports and indexes, from official governmental websites, International Organizations and renowned NGOs. This first literature review provided a general and updated stand of the situation.

In the second phase of the literature review, in order to focus in high quality sources, renowned data bases were used (mainly digital library data bases and scholarly portals, but also portals as google scholar) applying key words and filters to obtain recent and high quality (peer-reviewed) literature. The combination of these steps provided a strong body of theoretical sources regarding sustainable development and the relationship between income and environment; prominently through the EKC hypothesis and its modified version; and sustained recent studies about green growth in different context that showed the most relevant aspects.

2) Selection of variables and data collection

Through the literature review the most prominent aspects, actors and roles that can affect the variation of green growth, especially in the context of Latin America were identified. This analysis led to the careful selection of 6 variables which, in order of relevance, are: income (normally referred as economic growth in terms of GDP per-capita) (Ahmad et al., 2021; Dugbesan, et al., 2021; Özcan and Öztürk, 2019; Al-mulali et al., 2015), innovation (Ding et al., 2021; Dugbesan, et al., 2021; OECD, 2013; Piacentini, 2012), environmental policies (Dugbesan, et al., 2021, Piacentini, 2012), renewable energy consumption (Özcan and Öztürk, 2019; OECD, 2013), and the key role of the government mainly expressed by two aspects: quality of institutions and government effectiveness (Axelrod and VanDeveer, 2014). Once the variables were identified, for the final selection of them, parallelly secondary data-basis from official and worldwide renowned sources were reviewed in order to find appropriate indicators. Subsequently, the data were collected mainly from international organizations, namely: the Global Green Growth Institute, World Bank Open Data, Governance Indicators of the

World Bank, and OECD. The conduction of these two steps at the same time provided an adequate picture of the possibility to select the variables in order to answer to the research question.

The most important identification was the selection of the indicator of green growth, considering the different conceptualization of it. In this regard the Green Growth Index was selected, forming a panel data set of 16 Latin America countries in the period of 2006 to 2019. From the 33 Latin American countries, these 16 countries remained according to the data availability, based on the data of the green growth index first, and then according to the other indicators.

It is important to consider that these are comparable countries in terms of economic classification (status of developing economies), similar comparative advantage regarding natural resources, a basic technological development and socio-political aspects that make comparable Mexico (at North America) with the countries of Central and South America. These similarities of the countries are consequently reflected in political decisions and behaviors (Schipper et al., 2010 cite in (Solar and Del Niehaus, 2014), in the view that, facing the same problems the region can work in developing same policy alternatives.

3) Selection of method and data analysis

The study applied a quantitative method, in order to conduct the modified EKC model, a panel data regression with quadratic effect was applied[20] (as explained, the cubic effect that some other studies applied was not included in the study considering that it refers to countries at developed stages of industrialization (Al-mulali, U. et al., 2015)). Panel data consists of both cross sectional and times series observations, it refers to multi-dimensional data involving measurements over time and containing observations of multiple phenomena obtained over multiple time periods, for the same units of analysis. The quadratic effect is a special case of an interaction of two continuous variables, is an interaction of a continuous variable with itself. In the same way that the interaction of 2 different continuous variables allows the effect of one of those continuous variables to vary with the level of the other, the interaction of a variable with itself allows its effect to vary with its own level (SAS, 2022). For the data analysis, the SAS ODA software was used.

In order to select the appropriate effect for the model, since the literature regarding the use of random or fixed model is divided, lacking of a strong theoretical foundation for fitting a fixed effect model, a random effect model was fitted and a Hausman Test was applied to observe the correlation of errors and regressors. Hausman test compares the fixed and random effect models. If both fixed and random effects turn out significant, Hausman test identifies the best effect. The null hypothesis is that the (fixed or random) effect is not correlated with other regressors (independent variables) (Baltagi, 2021).

[20] In order to see the correlation of variables also a multiple regression, and panel data regression with more governmental and socio-economic variables (13) were conducted, this process helped confirming the literature review and the definition of the final model.

Furthermore, the random model was appropriate considering the inclusion of the lagged dependent variable (Baltagi, 2021). Finally, a one-way-error component model was selected, which allows for individual-specific or temporal specific error components, capturing any unobserved effects across individuals and time (Baltagi, 2021).

Inclusion of lagged variable

In the presented model it was decided to include a lagged dependent variable. Lagged dependent variables are commonly included as instrumental or independent variables in order “to address endogeneity concerns in empirical studies with observational data” (Wang and Bellermare, 2020). The endogeneity concern, or endogeneity problem, refers to the possibility that there are other reasons that can lead to a correlation between IV and DV, in that sense the overall correlation cannot be interpreted as a causal effect (Roberts and Whited, 2013).

A lagged variable, which has the value of the last time period of a certain variable, in this case: green growth lagged in time, is used in regression models, assuming to forecast the next period depending on past values of the same series (IBF, 2022). The LAG functions stores values in a queue and returns a value store previously in that queue (SAS, 2022). Lagged dependent variables have been used in regression analysis to provide robust estimates of the effects of the independent variables. Including the additional lag variable produces more accurate parameter estimates and controls for omitted variable bias, in other words using a lagged dependent variable as a control and proxy for omitted variables (Wilkins, 2018).

However, some theoretical studies address whether lagged variables can mitigate the endogeneity problem indeed, as expressed by Wang and Bellemare (2020) and Bellemare et al. (2017), who focused on social studies, which can be threatened by endogeneity problems in time series cross sectional data, including cases where the intervention is not being claimed directly, characteristics that are presented in this study. These authors developed a model to analyze this issue and concluded that under conditions where there exists endogeneity and dynamics among unobservables, lagging variables may generate estimates that are more biased. However, the results imply that lagged explanatory variables can be, but are not always and everywhere inappropriate. On the other hand, type 1 error is almost certain when using the naive estimator that ignores the endogeneity altogether. These results are difficult trade-offs. The inclusion of the lagged variable can be put into question, however its exclusion almost certainly will lead to biased results. Therefore, considering the empirical literature reflecting that there are risks of including a lagged variable, and that its exclusion is with certainty an error, it was decided to include the lagged variable, under the theoretical support and assumption that the autocorrelation parameter in the unobservables is small and there is no endogeneity problem.

3.4.2 Data set, variables and indicators

The data set consisted of 16 Latin American countries over the period of 2006 to 2019 based on the data availability of the green growth index. These countries are: Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Dominican Republic, Ecuador, Guatemala, Honduras, Mexico, Nicaragua, Panama, Paraguay, Peru, Uruguay[21]. According to this set the following variables, represented by its indicators, were included:

Dependent variable

Green growth: Collected from the Green Growth Index dataset of the Global Green Growth Institute, which is the only index that has two particularities: it includes the majority of Latin American countries and has the longest period of time (2006-2019).

Lagged dependent variable

Lagged green growth: based on the values of the previous year of the dependent variable.

Independent variables

GDP per capita: Represents the economic growth of a country divided by its population, considering the important population differences in the Latin American countries. It was collected from the World Bank Dataset open source in constant USD 2010. It is represented by its log form in order to reduce its size and make it comparable with the other indicators.

[21] El Salvador needed to be removed due to lack of data for the environmental policies indicator.

Innovation: Collected from the innovation index of the WIPO (World Intellectual Property Organization). According to the WIPO innovation means: "Innovation means doing something new that improves a product, process or service" (WIPO,2022).

Control variables

Renewable energy consumption: Considering the aim of this study, which is to contribute to the importance to develop policies that can create new sources of income that are in line with the environment, renewable energy consumption is not considered as the main focus of the study. However, it is expected that it can have an influence in the Latin American green growth. Therefore, it is considered as a control variable in order to look beyond the hydro power influence and discover what other main determinants for green growth. The indicator was obtained from the World Bank dataset and refers to " Percentage of total energy consumption per-capita".

Government effectiveness: This variable was added in order to address the role of the government in green growth, beyond the elaboration of environmental policies, since if the government is not effective enough the environmental policies are not going to be effective either. It was collected from the governance indicators of the World Bank dataset. According to their definition it captures perceptions of the quality of public services, the quality of the civil service and the degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies (World Bank, 2022).

Quality of institutions: As in the previous case this variable is considered as transcendental for the design, implementation and evaluation of policies, that play a crucial role in growth. It was selected in order to complement the analysis of the government's role, besides the elaboration of policies, since if institutions aren't capable to implement policies due to lack of quality. Considering that, for green growth not only the development of public policies is needed, but they also need to be in accordance with the private sector needs and demands to grow and foster innovations (World Bank, 2022). However, since quality of institutions is a horizontal aspect that is related to a broader spectrum of issues, it is not expected to have a direct influence in green growth, nevertheless some literature has addressed specifically the role of the regulatory system (Özcan and Öztürk, 2019; Ambec, S., Cohen, M., Stewart, E., Lanoie, P., 2011).

The data for this variable were collected through the governance indicators data set of the World Bank, specifically the "regulatory quality". According to the World Bank' definition it captures perceptions of the ability of the government to formulate and implement sound policies and regulations that permit and promote private sector development (World Bank, 2022).

Environmental policies: According to the literature, there is an important impact of environmental policies on creating innovation, that finally leads to green growth. Therefore, it is expected that will not affect green growth directly, although its role is relevant. Regarding the indicator, even though there is a wide range of environmental policies, economic instruments have been playing a growing role within this field. Distinctively, the role of environmentally related taxes, also known as green taxes, has been increasing, aiming to reduce practices that damage the environment, under the principle that the polluter has to pay. These policies are a good instrument for governments to shape prices of goods and services and they should be a central pillar of green growth policy (OECD, 2022 and 2017). In this context, the OECD indicator "total tax of environmental policies as a percentage of GDP"[22] was used as proxy to study the effect that environmental policies have for green growth in Latin America.

3.4.3 EKC Model and Equation

The EKC focuses on the relationship between income and environmental factors. Assuming that income has a positive and significant coefficient when analyzing the quality of the environment. However, according to the second wave of studies that analyzed the EKC model, it was asserted that GDP alone cannot guarantee improvements in the environment quality levels. Therefore, several studies have studied the EKC with different

[22] According the OECD work, the characteristics of such taxes included in the database correspond to: revenue, tax base, tax rates, exemptions, etc., which are used to construct the environmentally related tax revenues with a breakdown by environmental domain: energy products (including vehicle fuels); motor vehicles and transport services; measured or estimated emissions to air and water, ozone depleting substances, certain non-point sources of water pollution, waste management, as well as management of water, land, soil, forests, biodiversity, wildlife and fish stocks. The data have been cross-validated and complemented with Revenue statistics from the OECD Tax statistics database and official national sources (OECD, 2022).

indicators. A more recent literature proposed to study the modified EKC, which instead of using polluting indicators applies sustainable and wellbeing indicators. This study follows that proposal and added green growth as the sustainability indicator, and adds innovation as the main influential factor (after GDP per-capita and its squared from), environmental policies as a mediating factor, and includes three control variables: clean energy consume, government effectiveness and quality of institutions. In addition, a lagged dependent variable was included in order to ensure the significance of the model.

In the order to conduct the model a panel data regression was conducted, applying a random effect model according to the results of the Hausman Test, which suggested that the random effect was more appropriate, since it compares the fixed and random effect model. Furthermore, the random model was appropriate considering the inclusion of the lagged dependent variable (Baltagi, 2021). Finally, a one-way-error component model was selected, which allows for individual-specific or temporal specific error components, capturing any unobserved effects across individuals and time (Baltagi, 2021).

EKC Equation

In its general form, the EKC hypothesis is formulated as follows:

E= f (y,y2,Z)

In this formulation, E denotes the environmental indicator, Y denotes income and Z denotes an explanatory variable which is supposed to cause environmental degradation. In the present study the modified EKC model was applied. It is expressed according to the following equation:

$$\mathbf{GG} = \boldsymbol{\alpha} + \boldsymbol{\beta}\mathbf{1} * \mathbf{log}\,(\mathbf{GDPpercapita}) + \boldsymbol{\beta}\mathbf{2} * \mathbf{log}\left(\mathbf{GDPpercapita^2}\right) + \boldsymbol{\beta}\mathbf{3} * \mathbf{Gov_{eff}} + \boldsymbol{\beta}\mathbf{4} * \mathbf{lag_{ggi}} + \boldsymbol{\beta}\,\mathbf{5} * \mathbf{regulatory} + \boldsymbol{\beta}\,\mathbf{6} * \mathbf{Innovation} + \boldsymbol{\beta}\,\mathbf{7} * \mathbf{Renewable} + \boldsymbol{\beta}\,\mathbf{8} =* \mathbf{Environ\_tax\_gdp} + \boldsymbol{\varepsilon}$$

Where:

- **GG** is green growth, represented by the Green Growth Index.
- **α** indicates the intercept.
- **log(GDPpercapita)** is the Gross Domestic Product or income per-capita.
- **log(GDPpercapita)** ^{2}is the quadratic form of the Gross Domestic Product or income per-capita.
- **Gov_eff** is the Government Effectiveness
- $\mathbf{lag}_{ggi}$ is the lagged variable, represented by the lagged Green Growth Index
- **Regulatory** is the quality of the regulatory institutions
- **Innovation** refers to the innovation index.
- **Renewable** is the renewable energy consumption.
- **Environ_tax_gdp** refers to environmental policies, represented by total environmental taxes as a percentage of GDP.
- **ε** is random error
- β 1, β 2, β 3, β 4, β 5, β 6, β 7 and β 8 are coefficients

According to the literature, the greater the GDP, the larger the green growth index should. Furthermore, a significant positive correlation between innovation and green growth is expected, considering that the larger the innovation of a country the larger its green growth. Furthermore, environmental policies should influence green growth, since innovation is expected to be created through the pressure that these policies generate in the private sector (Özcan and Öztürk, 2019). Consumption of renewable energy is expected to be positive related to green growth, considering the important quantities of hydropower that Latin America produces. Finally, Government effectiveness and regularoty quality are expected to be positive correlatided with green growth, however not significantly.

The lagged varible represents the variables of one year previous of the original dependent varaible, therefore its significance and t value should be the highest. In this regard, only the GDP squared value is unexpected. On the first sight GDP and green growth are positively correlated, therefore it would be expected to be positive. However, the theory of the EKC refers to a change of shift in the long term for the environmental indicators, implying that at some specific point the increment of GDP can still pollute the environment. It is represented by the effect that the cubic GDP would have in developed economies. In this case the rereferred effect can occur with the developing countries and the GDP squared, meaning that after reaching some levels of income first certain levels of green growth will be generated and later pollution levels would likely be increased, suggesting that at some point green growth will stagnate or even decrease while GDP continues increasing.

Chapter 4 Results and Discussion

4.1 Descriptive Statistics

The total number of observations reached 208 considering 16 Latin American countries, whose data were available[23]. The summary of the descriptive statistics can be found in Table 1, according to the 9 variables that were included in the model:

TABLE 1 SUMMARY OF DESCRIPTIVE STATISTICS

Summary Statistics Table for Interval and Ratio Variables

Variable	*M*	*SD*	*n*	SE_M	Min	Max	Skewness	Kurtosis
ggi	47.31	6.49	208	0.45	34.52	61.64	-0.17	-0.56
ggi_lag	47.15	6.51	208	0.45	34.52	61.64	-0.12	-0.61
log_gdp_Sq	89.77	9.51	208	0.66	70.73	107.33	-0.33	-0.89
log_gdp	9.46	0.51	208	0.04	8.41	10.36	-0.41	-0.83
innovation	30.27	6.76	208	0.47	8.21	45.04	-0.55	0.54
environ_tax_gdp	2.58	2.31	208	0.16	-1.53	11.01	1.24	0.82
renewable	33.75	18.89	208	1.31	7.30	68.40	0.24	-1.26
gov_eff	46.14	18.47	208	1.28	16.50	87.38	0.27	-0.76
regulatory	-0.02	0.62	208	0.04	-1.30	1.54	0.29	0.03

The table shows a normal distribution of data. Regarding the dependent variable, green growth (ggi) and the lagged dependent variable, (ggi_lag), which was used to ensure the significance of the model, the observations between them are logically quite similar. The minimum levels are 34.52, and the maximum level is 61.64 for both of them, which reflects that the majority of the countries have a medium level of green growth and that the data are not highly dispersed.

[23] These countries are: Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Dominican Republic, Ecuador, Guatemala, Honduras, Mexico, Nicaragua, Panama, Paraguay, Peru, Uruguay

The observations for GDP per-capita in its log form, have an average of 9.46, (representing USD 9.460) and a standard deviation of 0.51, which denotes no high dispersion, as it was expected, and that the data are comparable, since there is no significant difference in these values. The observations for the same variable but in its squared form (GDP squared) had an average of 89.77, and consequently a high standard deviation of 9.51. This deviation was expected since it refers to a squared form.

On its part, the observations for innovation have an average of 30.27 and SD of 6.76, which indicates a medium level of dispersion, which is expected considering the industry structures differences between the countries, where countries like Brazil, Mexico and Chile have higher values than the rest of the region. In the case of government effectiveness, the observations show an average of 46.14, which locates the countries in the middle of an ideal government effectiveness, and SD of 18.47, being the second highest SD. The deviation of the data around mean implies differences between the countries, with minimal values of 16.50 and maximum 87.38.

Regarding the quality of the regulatory system, the average is low -0.02, as well as the SD of 0.62, showing that the low levels in the quality of the institutions and the regulatory system are common, as expected. According to renewable energy consumption, the SD is 18.89, which is the highest. The minimum values are 7.30 and maximum of 68.40, showing important differences in the consume of renewable energy, probably linked to the innovative levels of the countries that allow some countries to have more renewable energy sources (such us solar or wind), while the majority have only hydropower. The observations for environmental policies, reflected in green tax collection are low, with an average of 2.58 and SD of 2.31.

In addition, considering that when the skewness is greater than 2 in absolute value, the variable is considered to be asymmetrical about its mean, and that when the kurtosis is greater than or equal to 3, then the variable's distribution is markedly different than a normal distribution (Westfall & Henning, 2013). The skewness of the data does not reach 1.5, nor its kurtosis reaches 3, reflects that the data have a normal distribution, implying that the countries present a similar condition to be comparable and that panel regression model can be applied.

4.2 Panel Regression Results

Applying the panel regression into the EKC model with random one-way effect, utilizing the software SAS on demand for academics, the following results were obtained:

TABLE 2 PANEL REGRESSION RESULTS AND HAUSMAN TEST

Model Description

Estimation Method	Number of Cross Sections	Time series length
RanOne	16	13

Hausman Test for Random Effects

Coefficients	DF	m Value	Pr>m
8	8	5.72	0.6784

Parameter Estimates

Variables	DF	Estimate	Standard Error	t Value	Pr>|t|
Intercept	1	-124.639	37.8817	-3.29	0.0012
ggi_lag	1	0.923564	0.0204	45.19	<.0001
log_gdp	1	27.35293	8.1726	3.35	0.0010
log_gdp_Sq	1	-1.46905	0.4404	-3.34	0.0010
gov_eff	1	0.000778	0.0140	0.06	0.9559
innovation	1	0.062883	0.0187	3.36	0.0009
regulatory	1	0.166	0.3170	0.52	0.6011
renewable	1	-0.01808	0.00827	-2.19	0.0300
environ_tax_gdp	1	0.064334	0.0594	1.08	0.2804

Fit Statistics

SSE	DSE	MSE	Root MSE	R-Square
443.8031	199	2.2302	1.4934	0.9491

Panel Data Model generated by SAS OnDemand for Academics
Data compilation and analysis: Author

According to the results of the panel data it is possible to observe that, beyond the lagged variable, which in a logic way covers the majority of the significance with 99% (p value less than 0.001), the second most statistically significant variables are innovation with p value of 0.09 and is GDP per-capita with p value of 0.10, both reaching 90% confidence level, which is considered highly significant[24].

[24] It is important to mention that also multiple regression and panel data regression with more variables (13) were conducted and in both cases the results indicated high significance with innovation and GDP per capita. This allowed to decide the best variables and indicators and process, for the final model.

Furthermore, innovation presents a 3.36 t- Value, and GDP 3.35, signifying how many units the Y will change for every unit change in X. The variation significant. Even though, these results were expected to be significant, but the fact that they have reached a high significance level was not.

Regarding the R-square value of the model, is very high 0.94, meaning that in 94% of the variability observed in the dependent variable, green growth index, is explained by the regression model, indicating a good quality model. However, this value is expected to be high considering the effect of the lagged variable[25].

The other variables, namely, government efficiency, regulatory system and environmental policies, do not show a significant correlation with green growth, but the relationship, even though not significant, is still positive in accordance with the expectation of the study. On the other side, the consumption of renewable energy shows a negative relationship with green growth, presenting a t-value of -2.19, which was the only unexpected result, and can refer to the externalities that renewable energy can present to the environment, with the destruction of natural habitat. Specially in Latin America the majority of renewable energy is generated through hydro-power, which for some environmentalists is not considered as totally renewable energy (as it was referred in the first section). This situation can explain the negative t-value in the consumption of renewable energy.

[25] Note: In the panel regression conducted without the inclusion of the lagged variable the R-square was 50% indicating that the variation of green growth was still explainable even without the lagged variable.

Regarding the Hausman test, it allowed the definition of whether to use a fixed effects model or a random effects model in the panel data regression. According to its results, the random effect model is supposed to be best suited, since the p-value of the Hausman test is larger than 0.05, it is not possible to reject the null hypothesis, meaning that the random effect model is better than the fixed effect model.

4.3 Correlation Results

As a complementary analysis, a Pearson correlation analysis was conducted within the dependent variable and the independent variables in order to have another evaluation measure of the strength of the relationships, namely between green growth (DV), and income and innovation (IV). According to Cohen's standard, coefficients between .10 and .29 represent a small effect size, coefficients between .30 and .49 represent a moderate effect size, and coefficients above .50 indicate a large effect size (Cohen, 1988). The results are summarized in the following table:

TABLE 3 PEARSON CORRELATION RESULTS

Pearson Correlation Results Among ggi, log_gdp, innovation, and ggi_lag

Combination	*r*	95.00% CI	*n*	*p*
ggi-log_gdp	.53	[.43, .62]	208	< .001
ggi-innovation	.35	[.22, .46]	208	< .001
ggi-ggi_lag	.97	[.96, .98]	208	< .001
log_gdp-innovation	.47	[.36, .57]	208	< .001
log_gdp-ggi_lag	.52	[.41, .61]	208	< .001
innovation-ggi_lag	.30	[.17, .42]	208	< .001

Note. p-values adjusted using the Holm correction.

The substantial results that this analysis shows in reference for this study are: a significant positive correlation observed between green growth and income (GDP per-capita), with a correlation of .53, indicating a large effect size ($p < .001$, 95.00%). This suggests that as income increases, green growth tends to increase. Furthermore, a significant positive correlation was observed between green growth and innovation, with a correlation of .35, indicating a moderate effect size ($p < .001$, 95.00%). This suggests that as innovation increases, green growth tends to increase.

In the overall evaluation, this analysis shows that the relationship between the variables presents a correlation between large and moderate, with all the p-values < .001, implying the strong significance and interconnection between them, which increases the assumption that the variables are appropriate.

4.4 Discussion of Model Results and Policy Implications

Model Results in Perspective

According to the results of the EKC model conducted through a panel regression analysis with random one-way effect, having green growth (expressed as green growth index) as dependent variable and income (GDP-percapita), and innovation (innovation index) as independent variables. Furthermore, the model considered environmental policies (expressed as green taxes) as an intermediate variable according to the literature studied, expecting that it has a positive influence in green growth, however not directly, hence not significant.

In addition, taking into account their important role in green growth, three main control variables were added, these are: government effectiveness, quality of institutions and renewable energy consumption (as a percentage of GDP). These variables were expected to have a positive relationship, however not as a direct influential factor for green growth. Finally, a lagged dependent variable was added (lag_ggi), which is a variable that has the value of the last time period of a certain variable, in this case green growth. This variable was added in order to provide higher estimates of the effects of independent variables and ensure the results (IBF, 2022), and therefore it is considered as an adittional control variable.

The results of model express that there is significant positive relationship between green growth and income, which is in line with the postulates of the EKC, asserting that when income increases the quality of the environment can be positively affected (Barbier, 2015, Özcan and Öztürk, 2019). GDP per-capita has 90% significance level and a 3.35 t-value. Furthermore, the results of the model showed a positive significant correlation with innovation, with a 90% significance level and 3.36 t-value. These outcomes constitute an important eye-opening aspect to consider for the policy formulation of the Latin American countries.

The model indicates a good quality with a R-square of 94, meaning that in 94% of the cases when X changes leads to changes in Y, implying that the independent variables explain 94 percent of the changes in the dependent variable. However, it is important to consider that the inclusion of the lagged dependent variable influences the high R squared result. Nevertheless, the model is considered to have a good quality.

Regarding to the random effect, since the p-value of the Hausman test conducted is larger than 0.05, the null hypothesis was not possible to reject, asserting that the random effect model was the best option in this scenario.

The implications of these results are firstly that, without having a certain point of GDP, green growth can hardly be generated. Secondly, that the increment of GDP can have positive impacts in the quality of the environment and the generation of new eco-friendly income sources, which is implied by green growth[26]. In this regard, the first hypothesis of the study, namely:

- *H1: There is a significant and positive relationship between income and green growth in the context of Latin America*, is confirmed.

However, only the presence of income is not enough to generate green growth. As has been expressed by many scholars studying the EKC and green growth, aspects such as innovation are necessary to increment levels of sustainable development, which is the core of green growth. The results confirm these assumptions, that are based on empirical and theoretical literature, showing a positive and significant correlation between innovation and green growth, which has been expressly referred in the recent years by international organizations, mainly OECD, World Bank and the Green Growth Institute, as it was stated in the first section of this research. This finding constitutes one of the most important aspects of this research,

[26] In fact, the green growth index includes also social and wellbeing aspects, however inferences on those terms need further analysis of the elaboration of the indexes. The inferences made in this study refer not only to the composition of the index, but to the literature reviewed.

considering that Latin America is a region with low levels of innovation, in comparison to other regions of the world (Europe, North America and Asia) (WIPO,2021), therefore to develop new technologies able to compete with existing technologies, an establish a place in the market, or even start developing a real change in the industry infrastructure, especially in Latin America that do not have a strong industry sector, since its economy is based on the exports of primary products, requires extra efforts.

However, public investment in relevant research and temporary financial support for the development and commercialization of green technologies is needed with a vision in the next future. Nevertheless, the study indicates that the current levels of innovation influence green growth directly. In this regard, the second hypothesis, namely:

- *H2: There is a significant and positive relationship between innovation and green growth in the context of Latin America*, is confirmed.

Furthermore, it is important to consider that, even though there is no significant relationship between green growth and environmental policies, as it was expected, an important body of literature on green growth agrees that the majority of the innovation levels is generated through the pressure that environmental policies put in the private sector. In this regard, industries are motivated to use more eco-friendly artifacts or processes, making them to innovate, and possibly changing the structure of the industry in the medium or long term. Therefore, these policies have the potential to generate a positive spillover, in combination with innovation, which can be even more enhanced if specific innovation policies are addressed accordingly.

Regarding government effectiveness, quality of institutions, which are variables that were added in order to address the importance of the government and State performance, both variables show a positive relationship with green growth, however not significant, as expected, which implies that these factors have an indirect influence in green growth since they are related to several other factors. Furthermore, some literature has addressed that at later stages of industrialization people pay more attention to the environment and regulatory institutions become more effective (Özcan and Öztürk (Eds.), 2019; Bhattarai, M. and Hammig, M., 2001), which is not the case of Latin America, reason why the role of the institutions is not highly prominent statistically in reference of green growth.

Finally, (a partially) unexpected result was in relation to the consumption of renewable energy, which shows a negative relationship with green growth. One explanation for this result, is the possibility of the challenges that renewable energy can present to the environment, even though they are eco-friendly energy sources, that do not distribute CO2 emissions. Specially in the context of Latin America, the majority of the renewable energy sources are generated by hydro-power. The construction of the infrastructure required for hydro-power implies the destruction of natural habitat and biodiversity, which are also elements that are considered in the elaboration of the index. For this reason, some environmentalists do not consider hydro-energy as totally renewable energy, as was briefly addressed in the first section of the study. However, the assumption was still that the relationship between renewable energy consumption would be positive towards green growth. Now, considering the externalities of hydro-power and its important share in the renewable energy sources (45%) in Latin America, the negative T-value can be explained. In this context, the third hypothesis, namely:

- *H3: There is a positive relationship between renewable energy consumption, environmental policies, government effectiveness and quality of institutions and green growth, however it is not significant*, is partially confirmed.

Finally, it is important to mention that further studies have addressed the possibility that after a certain period of time, even if GDP continues increasing the quality of the environment can decrease (Farhani et al., 2014). This is specially the case of developed countries, considered to be at the last levels of industrialization or post-industrialization.

Discussion of Policy Implications

The following section will present a discussion about the implications that the present results of the study have in the context of policies, considering that the academy should provide inputs to the governments for the policy process (design, implementation, evaluation, feedback and redesign) according to the aims and limits of each study. In order to discuss the implications that the results can have in terms of policies, since there are many aspects to consider at different levels of actions, it has been decided to present them according to macro, meso and micro level, referring to national and international level, communitarian and institutional level, and individual level in order to follow an organized structure. Which in turn also include economic, political, social and, to some extent, environmental aspects, considering the context of the topic. Furthermore, this discussion will intent to mention some of the most relevant stake-holders that can contribute to the increment of green growth.

Macro level: national and international

The results of the present study present a contribution for the design, implementation and evaluation of policies related to green growth through GDP, innovation and environment. In this regard, one of the main and most important stake holders in this process are the governments, that through policies can positively influence the generation and development of innovation which in turn will generate green growth.

Firstly, it is a reality that developing economies face a variety of challenges, however this study has shown that in Latin America enough levels of income, or GDP, have been achieved, which have generated initial phases of green growth. Secondly, the study implies that innovation and green growth should be put in the national development agenda of the Latin American countries and should be considered as potential spillover for the mid- and long-term future. The base line for this is taking the promotion of green growth as a generator of new income sources, which at the same time will protect the natural capital of the countries, materializing a sustainable development.

Furthermore, once green growth and innovation are considered as a policy of State, and not only part of transitional governments, the proper allocation of budget for them is essential. Without designating any fixed budget countries cannot invest in developing and implementing policies, especially the ones that are not addressing basic needs, and therefore can be considered secondary.

According to the literature and to the results of this study, besides the need of GDP, green growth is affected directly by innovation. One of the first actions that the Latin American governments could take is the recognition that green growth and innovation can drive long-term economic growth, and therefore should not be left aside, even if crisis appear. Allocating a constant budget for R&D is essential. According to some studies, the most effective ways to increase innovation, as well as productivity is through government tax subsidies and grants, which have a direct effect in the short run (Bloom, 2019). In this regard, generating sustained incentives for the promotion of innovative start-ups, or boosting new practices in already stablished SMEs, can contribute to the main double purposes of green growth (conservation of environment and economic growth). According to Lee (2019) the paradox of innovation refers exactly to problem that Governments and big companies know about the benefits of R&D however they are not investing on it. This "innovation paradox" occurs in the majority of the countries that are stagnated in the middle-income trap.

For the long run, governments could pay attention to increasing and reinforcing human capital, through the expansion of the STEM admissions, and attracting qualified human resources that can contribute to the green transition, as some studies have suggested (Bloom, 2019). This aspect has also been addressed by Lee (2019), who has called it the capability failure, referring to the intrinsic difficulty of building innovation capabilities in developing countries. In order to overcome this failure, Lee recommends to promote short-cycle specializations rather than trying to enter to long cycles of technology-based sectors, as well as to increase the promotion of national value and reduce the dependence on Global Value Chains.

Even when these recommendations (including R&D investment and quality education) have been the recommendations for many years, the current situation shows that it is still relevant and necessary. Even if Latin American countries manage to prioritize some limited resources for these policies, they need to take advantage of them as much as possible. For that, they need to be strategically and carefully designed and implemented. In this regard, transparency through the process is needed and beyond that, the beneficiaries of these policies need to be accountable, through a check and balance system, but also through a process of internal competition that should lead in the future to international competition as well.

In addition, as the study revealed, the consumption of renewable energy presents a negative correlation with green growth, considering that in Latin America the majority of the renewable energy comes from hydro-power, this implies that new green energy sources should be developed. Also considering that hydro-energy does not have the potential to generate competition.

On a bigger perspective the study aims to cover the majority of the Latin American countries, in the aim of focusing particularly in the regional context and aiming to raise the attention of the potential collaboration that the Latin America countries could have regarding the promotion of sustainable development. In Latin America, there are several regional or semi regional organization that address cooperation areas between the countries, especially MERCOSUR, Andean Community, The Community of Latin American and Caribbean States, among others. These actors at regional level should guide the discussion around the opportunities that sustainable development has for the region, and can provide incentives at international levels in order t increase South-South cooperation, increasing exchange of knowledge and good practices.

Furthermore, at the national and international (regional) level, are direct influencers in raising the awareness of society, regarding sustainable practices, but also promoting the generation of innovation, since this is one of the aspects that has been highlighted mostly in the developed context. Therefore South-South cooperation in innovation is a key aspect, that would encourage new generations to move to into the fields that are part of the eco-transformation of the industry infrastructure. These policies and strategies should be maintained in the long term in order that the effect of the policies can be observed.

Finally, in the international cooperation area, countries like Korea, where the Green Growth Institute is headquartered constitute strategic partners that are open to exchange knowledge and provide the collaboration with experts.

Meso level: Institutions and enterprises

In the race to sustainable development, institutions and enterprises have an important role. Public institutions in charge of the environment and innovation, should be empowered to design and implement specific policies, in coordination with the local governments, that have the ability to reach more particular context to increases sustainable practices. However, in the general perspective there is a disconnection between the central government and the local governments who lead to duplication of efforts, specially regarding to the implementation of SDGs.

Regarding the private sector, literature has shown the important that these actors have in the generation of innovation, specially through the pressure or incentives that environmental policies can have. In this regard these actors are direct generators of innovation. It is important that the government provides an adequate environment for this development and that on its part companies invest in R&D and contribute to the generation of national value and reduction of external dependency of Global chains. A difficult path that should start and develop with minimum steps.

As it has been affirmed by some scholars (Farhani et al., 2014), better institutions can have an impact on the effectiveness of policy implementations, which together with private investments enables economic growth and innovation.

Micro level: Individuals

At micro level, the empowerment of the citizens and its inclusion in designing and evaluating policies should not be underestimated. Citizens constitute the human capital of the country and need to be provided with tools that enable them to construct a sustainable future. Therefore, bottom-up actions, from the civil society to the national and international are crucial.

The strategies that have been applied by Green Growth Institute show an example of the impact that empowered individuals can have. Through tools like participatory workshops, currently in countries like Zambia (which is a country that has a moderate green growth index, as well as the majority of the Latin American countries) representatives of civil society are gathering efforts to develop the National Green Growth Strategy, together with the government and under the umbrella of the GGI (Green Growth Institute, 2022).

These actions at the micro level are strategies that can influence increment of sustainable development. For example, raising the awareness about the importance of collecting data will generate a more efficient path to achieve SDGs targets, which can enhance innovation processes. Moreover, the green growth strategy includes aspects as social inclusion and gender, which are horizontal aspects that have a direct influence in the dynamics of the society.

Chapter 5. Conclusions and Limitations

5.1 Theoretical and empirical Conclusions

The research question that the present study aimed to answer was: What are the main determinants that positively influence green growth in the Latin American context? In order to answer this question, the theoretical framework about the Environmental Kuznets Curve was applied, being one of the most studied frameworks measuring the relationship of income and quality of the environment (Mishra, 2020). Particularly, the postulates that refer to a modified Environmental Kuznets Curve, were followed, meaning that instead of using polluting indicators, sustainability and wellbeing indicators are applied, in this case taken green growth as the dependent variable.

The methodology that was applied is quantitative, through a panel regression analysis, in order to control heterogeneity and collinearity between the variables, with random one-way effect as it was suggested by the Hausman Test, using the software SAS on Demand for Academics. Furthermore, a lagged variable was included in order to strength the effect of the independent variables, which was observed in the results of the study, providing significance only to the two most important variables: namely GDP per-capita and innovation.

The panel included 16 Latin American countries in the period of 2006-2019. From 33 countries that compose Latin America, the 16 countries were selected according to data availability, these countries are: The countries analyzed were: Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Dominican Republic, Ecuador, Guatemala, Honduras, Mexico, Nicaragua, Panama, Paraguay, Peru, Uruguay. El Salvador needed to be removed due to lack of data regarding the environmental policies indicator. Moreover, the period of the study response to the availability of data, regarding the green growth index.

The results of the study show a positive and significant correlation between green growth and income (GDP-percapita), with 0.10 pvalue, and a positive and significant correlation between green growth and innovation, with 0.09 reaching 90% confidence level. The T-values of both variables are 3.35 and 3.36 respectively, which refers to how many units the Y will change for every unit change in X. These results are in line with previous literature that has argued that the empirical evidence of EKCs supports the general proposition that the solution to combating environmental damage is economic growth itself (Beckerman, 1992, as cited in Barbier, 2015), confirming the first and second hypotheses of this study.

Furthermore, the R-square value of the model is very high it is 0.94, meaning that in 94% of the variability observed in the dependent variable, green growth index, is explained by the regression model, which indicates a good quality model. However, this value is expected to be high considering the effect of the lagged variable[27].

The variable of environmental policies was considering as an intermediate variable due to the role that it has in promoting innovation, specially from the private sector. This variable presents as a positive but insignificant relationship with green growth, as it was expected.

In order to go beyond the assessment of the direct effect of environmental policies, which have been included in previous empirical studies (however not in the context of Latin American countries particularly), two more variables were included to assess the role of the government, namely: government effectiveness which is necessary to achieve governmental goals, and quality of institutions considering that no policies can be implemented effectively if the institutions do not have enough quality that allows proper implementation, monitoring, assessment and feedback, and taking into account the relationship between sustainability and quality of institutions that has been highlighted by some literature (Farhani et al., 2014). Therefore, the inclusion of these variables is a new approach in the study of green growth and EKC.

These variables do not show a significant correlation with green growth, but the relationship, even though not significant, is still positive in accordance with the expectation of the study.

[27] Note: In the panel regression conducted without the inclusion of the lagged variable the R-square was 50% indicating that the variation of green growth was still explainable even without the lagged variable.

Regarding the third control variable, the consumption of renewable energy, shows a negative relationship with green growth, presenting a t-value of -2.19, which was the only unexpected result. This situation can refer to the negative externalities that renewable energy can present to the environment, with the destruction of natural habitat. Specially in Latin America where the majority of renewable energy is generated through hydro-power, which for some environmentalists is not considered as totally renewable energy, as it was referred in the first section of the study. These considerations can explain the negative t-value in the consumption of renewable energy. In this regard, due to the negative relationship between the consumption of renewable energies and green growth, the third hypothesis of the study was partially confirmed.

5.2 Policy Implications Conclusions

Regarding the variables that represent the role of the government directly, namely the indicators government effectiveness and quality of institutions were not significant towards the indicator of green growth in the context of Latin America. However, the role of the government can also be addressed through the environmental policies as well. In this regard, the role of the government can be assessed as crucial indirect actor through the design of environmental policies and innovation as the majority of the literature referred, nevertheless it doesn't show a direct influence towards green growth, considering that these indicators are related to more broader contexts, beyond green growth.

In this context, it is possible that these indicators do not represent the role of the government in the most accurate sense, however considering that in Latin America the levels of innovation are still relatively low in comparison to the developed regions, the first tools that the region has is to address public policies to foster innovation, where quality of institutions are important in order to implement policies successfully, that ultimately lead to the increment of green growth, as the results of the study show the positive correlation with green growth.

In the case of renewable energy consumption, it was considered as a control variable, for two reasons. The first one refers to the objective of this study, namely to contribute to raise the attention of the Latin American governments about the double purpose that sustainable development, in terms of green growth, can have, not only for the environment, but for the economy. The increment of green growth can generate new sources of eco-friendly income, while protecting the natural capital of the countries, which besides of being an invaluable resource, is a comparative advantage of the region.

Since Latin America is region well-known for its abundant hydro power, therefore it is assumed that (taking into account the low comparative levels of innovation), much of the influence of green growth, is attributed to hydropower, because the other renewable energies are not significant in the region. However, hydropower requires a huge investment and it cannot increase the industrial infrastructure and distribution of resources in a sustained and sustainable way, due to its nature. Therefore, this aspect didn't contribute with aim of this research, namely to find other determinants for green growth, beyond the well-known hydropower, in order to increase green growth as an aspect that can dynamize the economy as well, for this reason it was contemplated as control variable, taking into consideration its relevance in the green growth field. However, this aspect presented an unexpected negative relationship with green growth, which can be referred to the negative externalities that renewable energies can present to the environment, namely the destruction of natural habitat and biodiversity.

Furthermore, to achieve greener growth strategies are needed, they should consider new ways of producing and consuming things, where non-technological and innovation such as business models and city planning, including transportation will be useful in driving green growth. To grow in a sustainable and smart way, there is a relevant scope for policy interventions increasing the share of innovation incentives and STEM education offer. Piacentini (2012) addresses key policy package recommendations which include support for increasing the eco-efficiency of industrial production, support for research and innovative applications of green technologies, that are still relevant in the Latin American context, for what Lee (2019) affirms that an investment of more than zero is needed in R&D to overcome the innovation paradox and the middle income trap. Therefore, the role of the government is crucial.

In the international perspective, specially South-South cooperation, but not exclusively, is an important element to share the best practices that the countries have implemented successfully. Also, strategic alliances with countries like South Korea who are open to share their experiences and knowledge should be enhanced and constantly pursued.

Finally, it is considered that an appropriate design of policies should be conducted taking into the account the different levels, macro, meso and micro, and the most important stakeholders, in the economic, political and social areas.

5.3 Limitations of the Study

Despite the positive results of the econometric model, several limitations can be addressed in the present study. The first refers to the availability of data, since the study used secondary data from international organizations. The majority of the indicators that have been developed regarding green growth, belong to the OECD, which is a platform that provides very useful empirical data to develop studies, however the majority of the indicators are available only in the context of its member countries. This is the case of the green financing indicator for example, which is a significant aspect that could have been considered in the present study if the data were available for Latin America countries. Also, the number of countries was significant reduced due to the data availability.

Regarding the limitations of the model and the method, there are several statistical effects, tests and tools that can be considered to construct an appropriate model, however most of the times the differences between these statistical processes do not allow a complete and accurate identification to what is the best composition to take, limiting the selection of statistical tests to what the researcher considers as most appropriate (based on its knowledge and literature).

Finally, an important limitation of this study, partially because this goes beyond the limits of its goal, is the inability to provide specific policy recommendations on how to increase green growth itself or innovation (in order to increase green growth) in the region. The recommendations provided in the document refer to general recommendations, according to updated literature review on determinants for innovation in developing countries, however these do not respond to the particular contexts of the Latin American countries. This aspect refers to the common limitations of quantitative studies, which can analyze medium or large N, but can't look into specific cases to provide recommendations at national o local levels to generate a concrete impact. For that, another kind of study will be needed, the nest sub-section some prospective ideas are described.

5.4 Recommendations for further Studies

In the future, when more extensive data-basis continue to be developed in the context of Latin America, it would be desirable to conduct a similar test using the indicator of the OECD "Environmentally adjusted multifactor productivity growth for green growth", as dependent variable to compare its results. Nevertheless, the green growth index provided a good proxy for green growth, including also social and governmental aspects, that contemplate in the SDGs.

In the same sense, some of the indicators and proxies used in the present study can lead to some bias, therefore a more accurate and in-depth analysis would be required in order to conduct even more specific studies that can lead to the formulation of more accurate policies. For example, a particular study considering micro data from the innovation index in order to determine what are the specific factors within innovation that influence green growth, would be a useful contribution.

Another important recommendation to complement this study is to conduct qualitative research, where the best current practices regarding green growth can be studied, in the context of the Latin American countries. The Green Growth institute provides a platform that includes several reports about the national projects conducted in different regions of the world. To analyze these documents and conduct interviews to triangulate them, at the country level, would reflect more accurate practices of how to develop green growth strategies and how to implement them, considering a future evaluation, feedback and redesign.

Bibliography

Ahmad, M., Muslija, A., and Satrovic, E. (2021). Does economic prosperity lead to environmental sustainability in developing economies? Environmental Kuznets Curve Theory. *Environmental Science and Pollution Research, 28*, 22588–22601. https://doi.org/10.1007/s11356-020-12276-9

Al-mulali, U., Tang, Ch., and Ozturk, I. (2015). Estimating the Environment Kuznets Curve hypothesis: Evidence from Latin America and the Caribbean countries. *Renewable and Sustainable Energy Reviews, 50*, 918-924. www.elsevier.com/locate/rser

Ambec, S., Cohen, M., Stewart, E., and Lanoie, P. (2011). *The Porter Hypothesis at 20: Can Environmental Regulation Enhance Innovation and Competitiveness?* Washington.

Axelrod, R. S., and S. VanDeveer. (2014). *The Global Environment: Institutions, Law and Policy.* Mulligan.

Baltagi, B. (2021). *Econometric Analysis of Panel Data.* Srpinger.

Barbier, E. and Burgess, J. (2015). Sustainable Development: An Economic Perspective. *International Encyclopedia of the Social & Behavioral Sciences (Second Edition),,* 823-827.

Bellemare, M., Masaki, T., and Pepinsky, T. (2017). Lagged Explanatory Variables and the Estimation of Causal Effect. *The Journal of Politics, 79*(3), 949-963. http://dx.doi.org/10.1086/690946

Bhattarai, M. and Hammig, M. (2001). Institutions and the Environmental Kuznets Curve for Deforestation: A Crosscountry Analysis for Latin

America, Africa and Asia. *World Development, 29*(6), 995-1010. https://doi.org/10.1016/S0305-750X(01)00019-5

Bloom, N. (2019). A Toolkit of Policies to Promote Innovation. *Journal of Economic Perspectives*, 163-184.

Ekins, P. (1997). The Kuznets curve for the environment and economic growth: examining the evidence. *Environment and Planning*, 805-830.

Everett, T., Ishwaran, M., Ansaloni, G., and Rubin, A. (2010). *Economic Growth and Environment.* Department of Environment, Food and Rural Affairs. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/69195/pb13390-economic-growth-100305.pdf

Farhani, S., Mrizak, S., Chaibi, A., and Rault, Ch. (2014). The environmental Kuznets curve and sustainability: A panel data analysis. *Elsevier: Energy Policy, 71*, 189-198.

Global Green Growth Institute. (2022, October 12). *Launch of GGGI's first Green Growth Index: Measuring Green Growth Globally*. GLobal Green Growth Institute: https://gggi.org/launch-of-gggis-first-green-growth-index-measuring-green-growth-globally-2/

Global Green Growth Institute. (2020). *Global Green Growth Institute.* Green Technical Report No.16: greengrowthindex.gggi.org

Global Green Growth Institute. (2020). *Green Growth Index.* greengrowthindex.gggi.org

Global Green Growth Institute. (2022, November 8). *GGGI Supports Zambia in Developing its National Green Growth Index.* Green Growth Institute: https://zambia-greengrowthindex.herokuapp.com/SimulationDashBoard/Events

Green Policy Platform. (2022, July 12). *Green Economy Coalition*. Green Policy Platform: https://www.greengrowthknowledge.org/organization/green-economy-coalition

Hassan, M., Meo, M., Karim, M., and Arshed, N. (2020). Prospects of Environmental Kuznets Curve and Green Growth in Developed and Developing Economies. *Studies of Applied Economy, 38*(3). ISSN: 1133-3197

Hickel, J. and Kallis, G. (2019). Is Green Growth possible? *New Political Economy, 25*(4), 469-486. https://10.1080/13563467.2019.1598964

Hoz, M. (2021, November 23). The strong share of hydropower in Latin America and the policies to go beyond. *Universidad de Navarra Global Affairs*. https://www.unav.edu/web/global-affairs/hydropower-in-latin-america-and-renewable-energy-policies

IBF. (2022, October 27). *Lagged Dependent Variable*. Institute of Business Forecasting and Palnning: https://ibf.org/knowledge/glossary/lagged-dependent-variable-156

International Energy Agency. (2022, September 16). *Climate Impacts on Latin American Hydropower.* International Energy Agency: https://iea.blob.core.windows.net/assets/8fa86b9d-470c-41a6-982e-70acd3fbdda4/ClimateImpactsonLatinAmericanHydropower_WEB.pdf

Luis, J., Sidek, L., Desa, M., and Julien, P. (2013). Sustainability of hydropower as source of renewable and clean energy. *Earth Environ. Sci.,16*(012050). https://iopscience.iop.org/article/10.1088/1755-1315/16/1/012050/pdf

Keele, L. and Kelly, N. (2017). *Dynamic Models for Dynamic Theories: The Ins and Outs of Lagged Dependent Variables.* Cambridge: Cambridge Unviersity Press.

Lee, K. (2019). *The art of Economic Catch Up.* Cambridge: Cambridge.

Madhusudan, B., and Hamming, M. (2001). Institutions and the Environmental Kuznets Curve for Deforestation: A Crosscountry Analysis for Latin America, Africa and Asia. *World Development, 29*(6), 995-1010. https://doi.org/10.1016/S0305-750X(01)00019-5

MAPFRE. (2022, August 05). *MAPFRE Global Risks*. Renewable Energies, trends in Latin America: https://www.mapfreglobalrisks.com/gerencia-riesgos-seguros/articulos/energias-renovables-tendencias-en-latinoamerica/

Meller, P. (2020). Natural Resources, Export Diversification and Growth. In C. (Ed.), *Latin America: The Development Challenge. Policies for a more productive, integrated and inclusive region.* (pp. 157-177). Bogota: CAF. https://doi.org/978-980-422-225-2

Todaro, M., and Smith, S. (2012). *Economic Development* (11 ed.). Pearson.

Mishra, M. (2020). The Kuznets Curve for the Sustainable Environment and Economic Growth. *ZBW – Leibniz Information Centre for Economics,* *Kiel,Hamburg*. https://www.econstor.eu/bitstream/10419/216734/1/Green%20Economics%20.pdf

Dugbesan, D., Antas, C., and Orreia. (2021). Modeling the Determinants for Sustainble Green Growth in the MENAT region: Using the DCCE-MG Approach. *Semantic Scholar*, 4881-4901.

OECD. (2013). What have we learned from attempts to introduce green growth policies? *OEC: Better policies for better lives*, 1-24. OECDE: https://www.oecd-ilibrary.org/docserver/5k486rchlnxx-en.pdf?expires=1664242312&id=id&accname=guest&checksum=1439B1836C6111A8E45F9AB991A03168

OECD. (2017). Policy instruments for envrionment. *Policy instruments for envrionment*. https://www.oecd.org/environment/indicators-modelling-outlooks/PINE_database_brochure.pdf

OECD. (2018). *Implementing the Paris Agreement: Remaingin Challenges and the the Role of the OECD.* Paris: OCDE.

OECD. (2022, October 31). *Environmental taxation*. OECD: https://www.oecd.org/fr/env/outils-evaluation/environmentaltaxation.htm

OECD. (2022, June 20). *OECDE better policies for better lives*. Green growth and sustainable development: https://www.oecd.org/greengrowth/

OECD. (2022, October 15). *Tax and the environment*. OECD: https://www.oecd.org/tax/tax-policy/taxationandenvironmentalpolicies.htm

Oeycan, B., and Oeyturk, I. (2019). *Environmental Kuznets Kurve (The Manual).* (Oeycan, Ed.) Mersin.

Okoh, A., Mailumo, A., and Iganga, I. (2018). Green Transformation through Sustainability of Natural Capital: The Path for Africa. *Environment, Technology and Sustainable Development, 1*, 68-77.

OLADE. (2020, September 16). *Towards the energy transition in Latin America and the Caribbean.* OLADE: https://www.olade.org/en/noticias/towards-the-energy-transition-in-latin-america-and-the-caribbean/

Olivares, J. and Hernandez, C. (2021). Is the environmental Kuznets Curve still valid to explain environmental degradation? A theoretical review. *Economia Coyuntural (Coyuntural Economy)*. ISSN 2415-0630

Our World in Data. (2021, October 11). *Hydropower generation by region*. Our World in Data. https://ourworldindata.org/grapher/hydro-consumption-by-region

Our World in Data. (2022, October 02). *Who has contributed most to global CO2 emissions?* https://ourworldindata.org/contributed-most-global-co2

Özcan, B., and Öztürk, I. (Eds.). (2019). *Environmental Kuznets Curve (EKC): A Manual.* Elsevier Science & Technology.

Ozusaglam, S. (2012). Environmental Innovation: A concise review of the Literature. *Vie & sciences de l'entreprise, 2*(191-192), 15-38. https://doi.org/10.3917/vse.191.0015

Piacentini, M. (2012). Rationale and policies for the green growth of cities and regional economies. *Int Econ Econ Policy, 9*, 129–146. https://doi.org/10.1007/s10368-012-0209-4

Roberts, M., and Whited, T. (2013). Identifying and Discussing the Endogeneity Problem. In H. a. Stulz, *Handbook of the Economics of Finance.*

SAS. (2022, August 10). *SAS Help Center*. Quadratic Effect: The model: https://stats.oarc.ucla.edu/sas/seminars/analyzing-and-visualizing-interactions/

Solar,G. and Del Niehaus, M. (2014). Grow first, clean up later? Studying the growing traffic emissions in Latin America and exploring future possibilities. *Elsevier B.V.* https://doi.org/10.1016/j.trpro.2014.11.034

Statista. (2022, October 10). *Leading cpuntries in crude oil production in Latin America and the Caribbean in 2021*. Statista: shorturl.at/wGVY3

Statistics Neatherlands. (2013). *Sustainainable development and green growth: Comparison of the measurement frameworks at Statistics Neatherlands.* Den Haag: CBS.

Stern, D. (2015). *The Environmental Kuznets Curve.* Canberra: Elsevier.

Studer, I. (2019, August 18). Latin America's Natural Resources and Climate Change. *The Nature Conservancy*.https://www.nature.org/en-us/what-we-do/our-insights/perspectives/latin-america-natural-resources-climate-change/

Tawiah, V., Zakari, A., and Adedoyin, F. (2021). Determinants of green growth in developed and developing countries. *Environmental Science and Pollution Research*, 28, 39227–39242. https://link.springer.com/article/10.1007/s11356-021-13429-0

The Economist. (2016, December 10). Latin America is set to become a leader in alternative energy. *The Economist*. https://www.economist.com/the-americas/2016/12/10/latin-america-is-set-to-become-a-leader-in-alternative-energy

The Economist. (2018). Latin America is set to become a leader in alternative energy. *The Economist*. https://www.economist.com/the-americas/2016/12/10/latin-america-is-set-to-become-a-leader-in-alternative-energy

The Economist. (2022, October 27). Battery-makers are powering a circular economy. *The Economist*. https://www.economist.com/leaders/2022/10/27/battery-makers-are-powering-a-circular-economy

UNDESA. (2022, August 05). *Knowledge Platform Sustainable Development Goals*. Green Economy: shorturl.at/jmqrU

UNEP. (2020, May 02). *UN Environment Program*. Green Economy: https://www.unep.org/pt-br/node/23750

Wang, Y. and Bellermare, M. (2020). *Lagged Variables as Instruments.* Minnesota: University of Minnesota.

Wilkins, A. (2018). To Lag or Not to Lag?: Re-Evaluating the Use of Lagged Dependent Variables in Regression Analysis. *Political Science Research and Methods, 6*(2), 394-411. https://doi.org/10.1017/psrm.2017.4

WIPO. (2022, September 26). *Innovaion and Intellectual Property*.WIPO: https://www.wipo.int/ip-outreach/en/ipday/2017/innovation_and_intellectual_property.html

World Bank. (2022, July 12). *Worldwide Governance Indicators.* World Bank: https://info.worldbank.org/governance/wgi/Home/Documents

World Economic Forum. (2022). *The Circularity Report.* Circle Economy. Circularity Gap World: shorturl.at/anpq8

World Trade Organization. (2015). *World Trade Developments.*Geneve: World Trade Organization. World Trade Organization.

Annexes
Master file – Data Indicators per Country

code	country	Country_ID	year	ggi	ggi_lag	life	log_gdp	log_gdp_5c	log_gdp_cı	support	life_exp	choice	generosity	per_corr	posi	nega	confi_gov	gov_eff	con_corr	innovation	regulatory	renewable	environ_tax_gdp
ARG	Argentina	1	2007	48.69	49.39	6.07	10.02	100.4	1006.01	0.86	65.94	0.65	-0.14	0.88	0.75	0.28	0.41	53.4	45.15	12.17	-0.67	7.7	1.94
ARG	Argentina	1	2008	48.87	48.69	5.96	10.05	101	1015.08	0.89	66.06	0.68	-0.13	0.86	0.72	0.32	0.29	50.49	39.32	13.7	-0.74	7.7	1.95
ARG	Argentina	1	2009	47.95	48.87	6.42	9.98	99.6	994.01	0.92	66.18	0.64	-0.13	0.88	0.76	0.24	0.27	45.93	39.71	27.4	-0.85	8.6	2.16
ARG	Argentina	1	2010	47.25	47.95	6.44	10.07	101.4	1021.15	0.93	66.3	0.73	-0.13	0.85	0.77	0.21	0.35	48.8	43.33	29.1	-0.76	8.8	2.09
ARG	Argentina	1	2011	48.08	47.25	6.78	10.11	102.21	1033.36	0.89	66.42	0.82	-0.18	0.75	0.77	0.23	0.61	49.76	44.08	35.36	-0.72	8.8	1.92
ARG	Argentina	1	2012	46.56	48.08	6.47	10.09	101.81	1027.24	0.9	66.54	0.75	-0.15	0.82	0.74	0.27	0.42	46.45	39.34	34.4	-0.93	8.6	2.23
ARG	Argentina	1	2013	47.67	46.56	6.58	10.1	102.01	1030.3	0.91	66.66	0.74	-0.13	0.82	0.77	0.25	0.43	45.97	40.28	37.66	-0.96	8.9	2.14
ARG	Argentina	1	2014	48.25	47.67	6.67	10.07	101.4	1021.15	0.92	66.78	0.75	-0.17	0.85	0.77	0.24	0.41	46.63	35.1	35.13	-1.07	9.8	2.22
ARG	Argentina	1	2015	48.91	48.25	6.7	10.08	101.61	1024.19	0.93	66.9	0.88	-0.18	0.85	0.77	0.31	0.38	50	33.65	34.3	-0.91	9.4	2.19
ARG	Argentina	1	2016	49.45	48.91	6.43	10.05	101	1015.08	0.88	66.95	0.85	-0.19	0.85	0.73	0.31	0.42	60.58	47.12	30.24	-0.47	9.4	2.14
ARG	Argentina	1	2017	50.04	49.45	6.04	10.07	101.4	1021.15	0.91	67	0.83	-0.19	0.84	0.72	0.29	0.31	59.13	47.12	32	-0.29	10.4	2.29
ARG	Argentina	1	2018	49.47	50.04	5.79	10.03	100.6	1009.03	0.9	67.05	0.85	-0.21	0.86	0.73	0.32	0.26	54.81	55.29	30.65	-0.29	10.5	1.9
ARG	Argentina	1	2019	49.43	49.47	6.09	10	100	1000	0.9	67.1	0.82	-0.21	0.83	0.73	0.32	0.27	49.04	53.37	31.95	-0.49	10.7	1.82
BOL	Bolivia	2	2007	37.99	41.44	5.63	8.71	75.86	660.78	0.8	61.1	0.78	0	0.82	0.75	0.39	0.51	32.04	39.81	8.21	-0.98	20.3	2.31
BOL	Bolivia	2	2008	38.95	37.99	5.3	8.76	76.74	672.22	0.79	61.3	0.73	-0.09	0.8	0.72	0.39	0.44	31.55	35.92	10.25	-0.87	17.9	2.12
BOL	Bolivia	2	2009	38.69	38.95	6.09	8.77	76.91	674.53	0.83	61.5	0.78	-0.04	0.76	0.74	0.37	0.47	33.49	28.71	20.5	-0.88	18.2	1.86
BOL	Bolivia	2	2010	41.07	38.69	5.78	8.8	77.44	681.47	0.81	61.7	0.7	-0.07	0.78	0.72	0.35	0.38	37.8	39.05	20.5	-0.8	15.3	1.62
BOL	Bolivia	2	2011	43.95	41.07	5.78	8.83	77.97	688.47	0.82	61.9	0.78	-0.04	0.82	0.69	0.36	0.33	39.81	34.12	25.44	-0.76	13.5	1.49
BOL	Bolivia	2	2012	45.22	43.95	6.02	8.87	78.68	697.86	0.78	62.1	0.86	-0.02	0.84	0.7	0.41	0.44	43.13	27.01	25.8	-0.82	12.8	1.34
BOL	Bolivia	2	2013	45.2	45.22	5.77	8.92	79.57	709.73	0.8	62.3	0.85	-0.07	0.81	0.72	0.41	0.43	43.13	34.6	30.48	-0.78	12.1	1.35
BOL	Bolivia	2	2014	44.84	45.2	5.86	8.95	80.1	716.92	0.82	62.5	0.88	0.02	0.83	0.77	0.4	0.47	28.85	30.29	27.76	-0.87	10.6	1.32
BOL	Bolivia	2	2015	45.58	44.84	5.83	8.99	80.82	726.57	0.83	62.7	0.88	-0.03	0.86	0.75	0.39	0.49	29.33	26.92	25.58	-0.89	8	1.36
BOL	Bolivia	2	2016	45.45	45.58	5.77	9.01	81.18	731.43	0.8	62.85	0.88	-0.05	0.85	0.74	0.38	0.4	33.17	25	25.24	-0.92	8	1.47
BOL	Bolivia	2	2017	45.23	45.45	5.65	9.04	81.72	738.76	0.78	63	0.88	-0.12	0.82	0.66	0.43	0.43	38.46	28.37	25.64	-0.9	7.3	1.28
BOL	Bolivia	2	2018	44.08	45.23	5.92	9.07	82.26	746.14	0.83	63.15	0.86	-0.09	0.79	0.71	0.39	0.4	39.9	28.85	22.88	-0.91	7.4	1.19
BOL	Bolivia	2	2019	44.08	44.08	5.67	9.07	82.26	746.14	0.78	63.3	0.88	-0.09	0.86	0.7	0.42	0.3	24.52	26.44	34.43	-0.99	8.7	0.93
BRA	Brazil	3	2007	54.38	55.08	6.32	9.52	90.63	862.8	0.89	63.42	0.78	-0.02	0.73	0.77	0.3	0.38	48.06	55.34	28.4	-0.03	47.2	1.14
BRA	Brazil	3	2008	53.93	54.38	6.69	9.55	91.2	870.98	0.88	63.58	0.78	-0.08	0.69	0.72	0.27	0.51	52.43	59.22	30.95	0.05	47	1.08
BRA	Brazil	3	2009	53.91	53.93	7	9.54	91.01	868.25	0.91	63.74	0.77	-0.06	0.72	0.74	0.27	0.43	51.67	56.46	33.5	0.1	48.9	0.94
BRA	Brazil	3	2010	53.81	53.91	6.84	9.61	92.35	887.5	0.91	63.9	0.81	-0.06	0.66	0.73	0.25	0.51	54.07	60	29.7	0.15	46.8	1.03
BRA	Brazil	3	2011	55.05	53.81	7.04	9.64	92.93	895.84	0.92	64.06	0.83	-0.07	0.66	0.7	0.27	0.5	50.71	63.03	37.75	0.17	45.3	1.05
BRA	Brazil	3	2012	55.52	55.05	6.66	9.65	93.12	898.63	0.89	64.22	0.85	-0.02	0.62	0.69	0.35	0.46	49.76	58.29	36.6	0.09	43.5	0.85
BRA	Brazil	3	2013	55.42	55.52	7.14	9.67	93.51	904.23	0.91	64.38	0.78	-0.1	0.71	0.72	0.28	0.39	50.71	55.92	36.33	0.07	42.3	0.77
BRA	Brazil	3	2014	55.34	55.42	6.98	9.66	93.32	901.43	0.9	64.54	0.71	-0.12	0.71	0.72	0.27	0.36	47.6	46.63	36.29	-0.08	41.7	0.77
BRA	Brazil	3	2015	55.71	55.34	6.55	9.62	92.54	890.28	0.91	64.7	0.8	-0.02	0.77	0.69	0.32	0.2	48.08	42.79	34.95	-0.19	43.6	0.85
BRA	Brazil	3	2016	55.48	55.71	6.37	9.58	91.78	879.22	0.91	64.88	0.81	-0.1	0.78	0.71	0.3	0.26	46.63	42.79	33.19	-0.21	45.5	0.88
BRA	Brazil	3	2017	55.35	55.48	6.33	9.58	91.78	879.22	0.9	65.05	0.76	-0.18	0.79	0.67	0.31	0.17	43.27	38.94	33.1	-0.15	45.3	0.86
BRA	Brazil	3	2018	55.19	55.35	6.19	9.59	91.97	881.97	0.88	65.22	0.75	-0.12	0.76	0.68	0.35	0.17	36.54	40.38	43.4	-0.33	47	0.83
BRA	Brazil	3	2019	55.17	55.19	6.45	9.6	92.16	884.74	0.9	65.4	0.83	-0.06	0.76	0.7	0.34	0.34	43.27	42.79	33.82	-0.18	47.6	0.75
CHI	Chile	4	2007	42.35	43.6	5.7	9.92	98.41	976.19	0.81	67.96	0.66	0.24	0.72	0.71	0.34	0.43	87.38	90.78	30.3	1.51	30.5	1.13
CHI	Chile	4	2008	43.62	42.35	5.79	9.94	98.8	982.11	0.8	68.14	0.64	0.08	0.74	0.71	0.33	0.41	84.47	90.78	32.7	1.52	30.8	0.96
CHI	Chile	4	2009	43.63	43.62	6.49	9.92	98.41	976.19	0.83	68.32	0.75	0.15	0.73	0.76	0.3	0.58	85.17	89.47	35.1	1.46	31.5	0.95
CHI	Chile	4	2010	43.38	43.63	6.64	9.96	99.2	988.05	0.86	68.5	0.79	0.1	0.7	0.76	0.3	0.48	86.6	90.95	33.5	1.44	27	1.04
CHI	Chile	4	2011	44.33	43.38	6.53	10.01	100.2	1003	0.82	68.68	0.7	0.11	0.75	0.76	0.32	0.32	85.31	90.52	38.84	1.46	28.8	1.08
CHI	Chile	4	2012	44.31	44.33	6.6	10.06	101.2	1018.11	0.86	68.86	0.73	0.19	0.78	0.74	0.29	0.34	86.26	91.47	42.7	1.54	30.3	1.14
CHI	Chile	4	2013	45.45	44.31	6.74	10.09	101.81	1027.24	0.86	69.04	0.74	0.08	0.74	0.79	0.29	0.31	86.73	90.05	40.58	1.49	30.2	1.15
CHI	Chile	4	2014	46.79	45.45	6.84	10.09	101.81	1027.24	0.86	69.22	0.73	0.21	0.76	0.8	0.28	0.4	84.13	90.87	40.64	1.49	27	1.23
CHI	Chile	4	2015	48.05	46.79	6.53	10.1	102.01	1030.3	0.83	69.4	0.77	0.04	0.81	0.75	0.33	0.3	83.17	87.5	41.2	1.35	25.1	1.21
CHI	Chile	4	2016	48.65	48.05	6.58	10.11	102.21	1033.36	0.84	69.55	0.65	0.1	0.86	0.79	0.28	0.2	79.33	82.69	38.41	1.37	24.6	1.23
CHI	Chile	4	2017	52.18	48.65	6.32	10.11	102.21	1033.36	0.88	69.7	0.79	-0.02	0.84	0.76	0.29	0.27	80.29	82.21	38.7	1.35	24.1	1.27
CHI	Chile	4	2018	52.52	52.18	6.44	10.13	102.62	1039.51	0.89	69.85	0.79	-0.06	0.82	0.76	0.28	0.33	81.73	82.21	37.79	1.34	25.5	1.34
CHI	Chile	4	2019	52.54	52.52	5.94	10.13	102.62	1039.51	0.87	70	0.66	-0.11	0.86	0.74	0.34	0.15	81.25	82.69	25.03	1.22	25.3	1.38
COL	Colombia	5	2007	47.37	49.52	6.14	9.32	86.86	809.56	0.89	66.54	0.79	-0.04	0.86	0.77	0.29	0.51	52.43	51.46	25	0.24	30.4	1
COL	Colombia	5	2008	48.43	47.37	6.17	9.34	87.24	814.78	0.88	66.76	0.8	-0.04	0.76	0.77	0.31	0.64	54.37	50.49	26.7	0.26	30	1
COL	Colombia	5	2009	49.58	48.43	6.27	9.34	87.24	814.78	0.89	66.98	0.76	-0.06	0.84	0.79	0.27	0.44	48.8	46.89	28.4	0.15	30.9	1.01
COL	Colombia	5	2010	48.89	49.58	6.41	9.37	87.8	822.66	0.89	67.2	0.82	-0.05	0.81	0.79	0.26	0.55	51.67	42.38	27.6	0.25	29.8	0.92
COL	Colombia	5	2011	49.43	48.89	6.46	9.43	88.92	838.56	0.9	67.42	0.81	-0.07	0.85	0.78	0.29	0.45	56.4	49.29	32.32	0.36	28.9	0.92
COL	Colombia	5	2012	49.9	49.43	6.37	9.46	89.49	846.59	0.91	67.64	0.83	-0.01	0.87	0.83	0.29	0.36	57.35	43.13	35.5	0.4	28.9	0.87
COL	Colombia	5	2013	50.34	49.9	6.61	9.5	90.25	857.38	0.9	67.86	0.84	-0.07	0.9	0.81	0.28	0.29	57.35	42.18	37.38	0.4	32.3	0.83
COL	Colombia	5	2014	50.83	50.34	6.45	9.54	91.01	868.25	0.91	68.08	0.8	-0.09	0.89	0.82	0.28	0.3	49.52	44.23	35.5	0.5	32.4	0.81
COL	Colombia	5	2015	51.91	50.83	6.39	9.55	91.2	870.98	0.89	68.3	0.79	-0.1	0.84	0.8	0.29	0.27	51.92	47.6	36.41	0.47	31.6	0.83

COL	Colombia	5	2016	51.45	51.91	6.23	9.56	91.39	873.72	0.88	68.47	0.83	-0.1	0.9	0.77	0.29	0.26	53.37	44.71	34.16	0.4	30.7	0.82
COL	Colombia	5	2017	52.46	51.45	6.16	9.56	91.39	873.72	0.91	68.65	0.84	-0.16	0.88	0.79	0.3	0.22	50.96	43.75	34.78	0.34	32.5	0.62
COL	Colombia	5	2018	52.93	52.46	5.98	9.57	91.58	876.47	0.87	68.82	0.85	-0.15	0.85	0.77	0.3	0.27	50	45.67	45.04	0.32	30.7	0.66
COL	Colombia	5	2019	53.08	52.93	6.35	9.59	91.97	881.97	0.87	69	0.82	-0.17	0.85	0.79	0.32	0.33	55.77	48.08	33	0.4	30.7	0.61
COS	Costa Rica	6	2007	55.04	59.7	7.43	9.68	93.7	907.04	0.92	68.72	0.92	0.09	0.82	0.83	0.24	0.45	60.68	71.84	15	0.42	41.2	2.47
COS	Costa Rica	6	2008	52.81	55.04	6.85	9.71	94.28	915.5	0.92	68.88	0.91	0.09	0.82	0.84	0.23	0.36	64.08	73.3	16.35	0.46	40.7	2.38
COS	Costa Rica	6	2009	53.48	52.81	7.61	9.69	93.9	909.85	0.9	69.04	0.89	0.06	0.79	0.84	0.22	0.52	64.59	73.68	32.7	0.42	40.7	2.31
COS	Costa Rica	6	2010	53.36	53.48	7.27	9.73	94.67	921.17	0.92	69.2	0.88	0.04	0.76	0.83	0.22	0.53	64.59	72.86	33.5	0.47	40.4	2.23
COS	Costa Rica	6	2011	52.83	53.36	7.23	9.76	95.26	929.71	0.89	69.36	0.93	-0.04	0.84	0.79	0.27	0.32	64.45	72.51	37.91	0.45	38	2.38
COS	Costa Rica	6	2012	53.5	52.83	7.27	9.8	96.04	941.19	0.9	69.52	0.93	0.04	0.79	0.84	0.26	0.28	68.72	72.51	36.3	0.57	38.1	2.26
COS	Costa Rica	6	2013	53.59	53.5	7.16	9.81	96.24	944.08	0.9	69.68	0.9	0.01	0.81	0.81	0.28	0.26	67.77	71.56	41.54	0.58	37.8	2.35
COS	Costa Rica	6	2014	53.52	53.59	7.25	9.83	96.63	949.86	0.91	69.84	0.93	0	0.79	0.8	0.29	0.4	68.75	75	41.3	0.51	37.6	2.34
COS	Costa Rica	6	2015	53.73	53.52	6.85	9.86	97.22	958.59	0.88	70	0.91	-0.07	0.76	0.81	0.29	0.26	66.83	75.96	38.59	0.53	38.3	2.33
COS	Costa Rica	6	2016	53.2	53.73	7.14	9.89	97.81	967.36	0.9	70	0.87	-0.04	0.78	0.83	0.28	0.28	67.31	75.96	38.4	0.41	36.8	2.27
COS	Costa Rica	6	2017	53.36	53.2	7.23	9.92	98.41	976.19	0.92	70	0.94	-0.08	0.74	0.79	0.28	0.41	66.35	67.79	37.09	0.35	36.2	2.29
COS	Costa Rica	6	2018	53.64	53.36	7.14	9.94	98.8	982.11	0.88	70	0.94	-0.11	0.78	0.8	0.33	0.48	67.79	70.67	28.95	0.49	35.7	1.06
COS	Costa Rica	6	2019	53.17	53.64	7	9.95	99	985.07	0.91	70	0.93	-0.15	0.84	0.79	0.3	0.28	67.31	75.48	36.13	0.5	35.8	1.13
DOM	Dominican Republic	7	2007	36.91	38.64	5.08	9.37	87.8	822.66	0.85	65.12	0.89	-0.01	0.77	0.72	0.26	0.48	28.16	25.24	22.9	-0.24	17.9	2.65
DOM	Dominican Republic	7	2008	37.51	36.91	4.84	9.39	88.17	827.94	0.85	64.88	0.85	-0.05	0.73	0.65	0.33	0.54	32.04	26.7	24.3	-0.19	17.7	2.59
DOM	Dominican Republic	7	2009	37.58	37.51	5.43	9.39	88.17	827.94	0.88	64.64	0.86	-0.05	0.81	0.71	0.28	0.41	33.01	23.92	25.7	-0.19	17.3	2.19
DOM	Dominican Republic	7	2010	37.26	37.58	4.74	9.46	89.49	846.59	0.86	64.4	0.82	-0.08	0.78	0.71	0.28	0.45	31.1	20.95	28.1	-0.15	16.9	2.2
DOM	Dominican Republic	7	2011	37.46	37.26	5.4	9.47	89.68	849.28	0.87	64.16	0.85	0.01	0.79	0.74	0.3	0.41	32.7	21.8	30.49	-0.2	16.8	2.24
DOM	Dominican Republic	7	2012	40.1	37.46	4.75	9.49	90.06	854.67	0.88	63.92	0.84	-0.06	0.73	0.72	0.3	0.43	37.44	19.91	30.9	-0.1	16.5	2.18
DOM	Dominican Republic	7	2013	44.89	40.1	5.02	9.53	90.82	865.52	0.88	63.68	0.89	0.02	0.75	0.77	0.3	0.57	38.39	21.33	33.28	-0.07	16.6	2
DOM	Dominican Republic	7	2014	46.03	44.89	5.39	9.58	91.78	879.22	0.89	63.44	0.9	-0.02	0.76	0.77	0.3	0.56	37.5	23.08	32.29	-0.04	17.3	1.93
DOM	Dominican Republic	7	2015	46.73	46.03	5.06	9.64	92.93	895.84	0.89	63.2	0.86	-0.07	0.76	0.7	0.3	0.45	41.35	21.15	30.6	-0.04	14.9	1.81
DOM	Dominican Republic	7	2016	53.24	46.73	5.24	9.69	93.9	909.85	0.89	63.4	0.87	-0.08	0.74	0.73	0.28	0.55	43.27	23.08	30.55	-0.07	15.3	1.81
DOM	Dominican Republic	7	2017	54.48	53.24	5.61	9.73	94.67	921.17	0.89	63.6	0.86	-0.12	0.76	0.71	0.27	0.46	38.94	24.52	31.17	-0.08	16.9	1.87
DOM	Dominican Republic	7	2018	54.62	54.48	5.43	9.78	95.65	935.44	0.86	63.8	0.87	-0.15	0.76	0.72	0.29	0.42	39.42	24.52	29.33	-0.07	16	1.81
DOM	Dominican Republic	7	2019	54.56	54.62	6	9.82	96.43	946.97	0.88	64	0.88	-0.12	0.75	0.75	0.26	0.41	38.94	25	28.56	-0.05	14	1.83
ECU	Ecuador	8	2007	46.88	49.69	5	9.19	84.46	776.15	0.84	64.78	0.67	-0.06	0.83	0.8	0.29	0.47	18.93	23.3	20.3	-1.14	15.9	0.19
ECU	Ecuador	8	2008	46.48	46.88	5.3	9.24	85.38	788.89	0.83	65.12	0.64	-0.1	0.8	0.81	0.28	0.51	19.9	28.64	21.55	-1.14	15.3	0.21
ECU	Ecuador	8	2009	46.75	46.48	6.02	9.23	85.19	786.33	0.78	65.46	0.74	-0.11	0.77	0.8	0.26	0.54	23.92	22.49	22.8	-1.3	12.9	0.27
ECU	Ecuador	8	2010	48.23	46.75	5.84	9.24	85.38	788.89	0.84	65.8	0.72	-0.06	0.81	0.77	0.22	0.41	27.75	22.86	24.3	-1.17	11.8	0.32
ECU	Ecuador	8	2011	49.62	48.23	5.8	9.3	86.49	804.36	0.82	66.14	0.79	-0.16	0.7	0.81	0.27	0.59	33.65	24.64	28.75	-1.03	13.2	0.31
ECU	Ecuador	8	2012	50.36	49.62	5.96	9.34	87.24	814.78	0.79	66.48	0.83	-0.08	0.73	0.77	0.33	0.64	37.91	34.12	28.5	-1.02	13.2	0.44
ECU	Ecuador	8	2013	50.6	50.36	6.02	9.38	87.98	825.29	0.8	66.82	0.79	-0.19	0.65	0.82	0.27	0.62	36.02	35.07	32.83	-0.93	11.9	0.47
ECU	Ecuador	8	2014	51.45	50.6	5.95	9.4	88.36	830.58	0.83	67.16	0.72	-0.17	0.66	0.84	0.31	0.65	35.58	25	27.5	-1.01	12.2	0.48
ECU	Ecuador	8	2015	51.93	51.45	5.96	9.38	87.98	825.29	0.86	67.5	0.8	-0.12	0.67	0.82	0.32	0.52	38.46	28.37	26.87	-1.16	13.1	0.49
ECU	Ecuador	8	2016	51.93	51.93	6.12	9.35	87.42	817.4	0.84	67.75	0.85	-0.02	0.77	0.81	0.37	0.47	37.5	27.4	27.11	-1.02	14.8	0.42
ECU	Ecuador	8	2017	50.92	51.93	5.84	9.36	87.61	820.03	0.85	68	0.88	-0.17	0.73	0.79	0.31	0.64	37.02	30.29	29.14	-1.06	17.1	0.43
ECU	Ecuador	8	2018	50.77	50.92	6.13	9.36	87.61	820.03	0.85	68.25	0.87	-0.1	0.83	0.82	0.33	0.4	41.83	31.73	26.8	-0.87	16.3	0.44
ECU	Ecuador	8	2019	50.74	50.77	5.81	9.34	87.24	814.78	0.81	68.5	0.83	-0.12	0.84	0.75	0.37	0.21	37.02	35.1	26.56	-0.82	17.7	0.41
GUA	Guatemala	9	2007	36.31	37.65	6.33	8.89	79.03	702.6	0.87	59.26	0.63	0.14	0.81	0.79	0.22	0.3	33.01	26.21	12.41	-0.23	63.4	1.07
GUA	Guatemala	9	2008	36.69	36.31	6.41	8.9	79.21	704.97	0.87	59.54	0.63	0.2	0.8	0.8	0.23	0.32	35.44	30.58	13.85	-0.18	66.6	0.92
GUA	Guatemala	9	2009	36.64	36.69	6.45	8.89	79.03	702.6	0.83	59.82	0.64	0.2	0.75	0.81	0.24	0.34	27.27	35.89	27.7	-0.15	65.4	0.98
GUA	Guatemala	9	2010	36.25	36.64	6.29	8.9	79.21	704.97	0.86	60.1	0.7	0.17	0.79	0.8	0.24	0.34	28.71	35.71	27.2	-0.15	67.2	0.92
GUA	Guatemala	9	2011	36.6	36.25	5.74	8.92	79.57	709.73	0.77	60.38	0.76	0.01	0.86	0.79	0.29	0.36	27.49	36.49	33.18	-0.13	67.2	0.82
GUA	Guatemala	9	2012	36.84	36.6	5.86	8.93	79.74	712.12	0.8	60.66	0.87	0.02	0.82	0.81	0.35	0.5	26.07	29.38	28.4	-0.17	67.5	0.77
GUA	Guatemala	9	2013	36.82	36.84	5.98	8.95	80.1	716.92	0.83	60.94	0.88	0.04	0.82	0.82	0.33	0.47	28.44	32.23	31.46	-0.2	67.3	0.83
GUA	Guatemala	9	2014	36.27	36.82	6.54	8.98	80.64	724.15	0.83	61.22	0.84	0.11	0.8	0.82	0.31	0.37	23.56	27.4	36.69	-0.19	66.4	0.75
GUA	Guatemala	9	2015	36.77	36.27	6.46	9	81	729	0.82	61.5	0.87	0.05	0.82	0.83	0.31	0.27	24.52	25	28.84	-0.22	63.4	0.88
GUA	Guatemala	9	2016	36.94	36.77	6.36	9.01	81.18	731.43	0.81	61.7	0.86	0.01	0.81	0.82	0.32	0.47	30.77	24.04	27.3	-0.2	63.3	0.87
GUA	Guatemala	9	2017	36.94	36.94	6.33	9.03	81.54	736.31	0.83	61.9	0.91	-0.06	0.8	0.82	0.31	0.46	27.4	24.04	35.86	-0.25	65.1	0.86
GUA	Guatemala	9	2018	37.12	36.94	6.63	9.04	81.72	738.76	0.84	62.1	0.91	-0.01	0.77	0.83	0.26	0.46	23.56	22.12	25.51	-0.19	64.1	0.86
GUA	Guatemala	9	2019	37.13	37.12	6.26	9.07	82.26	746.14	0.77	62.3	0.9	-0.06	0.77	0.82	0.31	0.46	26.92	18.75	25.07	-0.22	62.9	0.86
HON	Honduras	10	2007	39.25	43.76	5.1	8.5	72.25	614.13	0.82	62.9	0.68	0.23	0.83	0.71	0.2	0.34	33.5	22.33	20.2	-0.29	50.9	2.39
HON	Honduras	10	2008	36.97	39.25	5.42	8.52	72.59	618.47	0.83	62.7	0.69	0.22	0.86	0.72	0.21	0.29	32.52	18.45	23.9	-0.31	50.3	2.12
HON	Honduras	10	2009	37.23	36.97	6.03	8.47	71.74	607.65	0.82	62.5	0.66	0.12	0.86	0.74	0.26	0.29	28.23	19.62	27.6	-0.3	51.3	2.19
HON	Honduras	10	2010	36.84	37.23	5.87	8.49	72.08	611.96	0.8	62.3	0.65	0.11	0.82	0.75	0.26	0.3	31.58	19.52	33.1	-0.22	52.2	2.1
HON	Honduras	10	2011	35.72	36.84	4.96	8.51	72.42	616.3	0.77	62.1	0.78	0.1	0.88	0.76	0.31	0.29	37.44	21.33	33.08	-0.13	51.9	1.84
HON	Honduras	10	2012	39.97	35.72	4.6	8.53	72.76	620.65	0.78	61.9	0.7	0	0.87	0.8	0.29	0.26	27.49	17.54	26.3	-0.19	52.3	1.92

HON	Honduras	10	2013	40.72	39.97	4.71	8.54	72.93	622.84	0.79	61.7	0.7	-0.03	0.87	0.79	0.28	0.25	25.59	18.01	28.8	-0.19	51.1	2.05
HON	Honduras	10	2014	43.96	40.72	5.06	8.55	73.1	625.03	0.79	61.5	0.7	0.01	0.83	0.79	0.3	0.33	21.15	23.56	34.84	-0.4	53.6	2.17
HON	Honduras	10	2015	45.08	43.96	4.85	8.57	73.44	629.42	0.77	61.3	0.53	-0.1	0.85	0.83	0.31	0.3	20.19	32.69	27.48	-0.4	52.7	2.26
HON	Honduras	10	2016	46.23	45.08	5.65	8.59	73.79	633.84	0.77	61.72	0.85	0.08	0.79	0.79	0.3	0.39	23.08	29.81	26.94	-0.51	52.8	2.35
HON	Honduras	10	2017	46.14	46.23	6.02	8.62	74.3	640.5	0.84	62.15	0.9	0.07	0.78	0.8	0.25	0.5	34.13	25	26.36	-0.43	45.9	2.37
HON	Honduras	10	2018	45.74	46.14	5.91	8.64	74.65	644.97	0.83	62.58	0.87	0.1	0.8	0.82	0.29	0.4	27.88	29.33	24.95	-0.45	49.8	2.29
HON	Honduras	10	2019	45.78	45.74	5.93	8.65	74.82	647.21	0.8	63	0.85	0.06	0.81	0.79	0.28	0.36	30.29	22.6	25.48	-0.49	46	2.3
MEX	Mexico	11	2007	57.62	58.58	6.53	9.82	96.43	946.97	0.88	64.68	0.67	-0.1	0.75	0.75	0.25	0.42	58.74	49.03	13.65	0.39	9.5	-0.19
MEX	Mexico	11	2008	57.59	57.62	6.83	9.82	96.43	946.97	0.88	64.82	0.68	-0.13	0.78	0.77	0.2	0.41	60.68	50	15.3	0.34	9.8	-1.53
MEX	Mexico	11	2009	57.29	57.59	6.96	9.75	95.06	926.86	0.87	64.96	0.68	-0.08	0.76	0.76	0.2	0.45	60.29	47.85	30.6	0.22	9.2	0.25
MEX	Mexico	11	2010	57.9	57.29	6.8	9.79	95.84	938.31	0.88	65.1	0.78	-0.05	0.69	0.75	0.22	0.37	60.29	42.86	29.6	0.25	9.4	-0.21
MEX	Mexico	11	2011	58.11	57.9	6.91	9.81	96.24	944.08	0.82	65.24	0.83	-0.1	0.7	0.7	0.23	0.38	63.51	41.71	30.45	0.28	9.1	-0.78
MEX	Mexico	11	2012	58.57	58.11	7.32	9.83	96.63	949.86	0.77	65.38	0.79	-0.09	0.63	0.72	0.28	0.36	63.51	42.65	39.8	0.48	9	-1.12
MEX	Mexico	11	2013	59.1	58.57	7.44	9.83	96.63	949.86	0.76	65.52	0.74	-0.17	0.61	0.75	0.22	0.4	63.03	37.44	36.83	0.47	9.2	-0.34
MEX	Mexico	11	2014	59.44	59.1	6.68	9.85	97.02	955.67	0.78	65.66	0.78	-0.1	0.63	0.76	0.23	0.33	61.54	24.52	36.02	0.43	9.8	0.1
MEX	Mexico	11	2015	60.03	59.44	6.24	9.87	97.42	961.5	0.76	65.8	0.72	-0.15	0.71	0.71	0.24	0.26	62.02	24.04	38.03	0.36	9.2	1.37
MEX	Mexico	11	2016	60.32	60.03	6.82	9.88	97.61	964.43	0.89	65.8	0.75	-0.15	0.81	0.8	0.22	0.28	58.65	25.96	42.52	0.29	9.2	1.56
MEX	Mexico	11	2017	61.26	60.32	6.41	9.89	97.81	967.36	0.8	65.8	0.86	-0.2	0.8	0.78	0.23	0.26	55.29	18.27	35.79	0.28	10	1.17
MEX	Mexico	11	2018	61.64	61.26	6.55	9.9	98.01	970.3	0.86	65.8	0.82	-0.18	0.81	0.82	0.21	0.29	47.6	18.75	44.32	0.16	10	0.96
MEX	Mexico	11	2019	61.63	61.64	6.43	9.89	97.81	967.36	0.85	65.8	0.9	-0.14	0.81	0.8	0.25	0.5	45.67	22.12	36.06	0.1	10.3	1.3
NIC	Nicaragua	12	2007	46.67	45.49	4.94	8.43	71.06	599.08	0.87	64.4	0.84	0.14	0.83	0.79	0.29	0.41	16.5	23.79	20.1	-0.45	52.6	8.23
NIC	Nicaragua	12	2008	46.44	46.67	5.1	8.45	71.4	603.35	0.86	64.5	0.79	0.08	0.82	0.77	0.29	0.34	16.99	24.76	21.15	-0.41	53.8	7.31
NIC	Nicaragua	12	2009	46.59	46.44	5.35	8.41	70.73	594.82	0.83	64.6	0.75	0.07	0.79	0.74	0.3	0.37	16.75	25.36	22.2	-0.43	54.6	7.36
NIC	Nicaragua	12	2010	46.22	46.59	5.69	8.44	71.23	601.21	0.86	64.7	0.79	0.02	0.8	0.75	0.27	0.4	16.75	24.29	25.7	-0.28	54.4	7.52
NIC	Nicaragua	12	2011	47.96	46.22	5.39	8.48	71.91	609.8	0.8	64.8	0.78	-0.02	0.76	0.75	0.31	0.54	18.48	23.7	25.78	-0.34	53.3	6.15
NIC	Nicaragua	12	2012	47.04	47.96	5.45	8.53	72.76	620.65	0.89	64.9	0.85	0.02	0.64	0.76	0.25	0.57	20.85	25.12	26.7	-0.3	53.3	5.94
NIC	Nicaragua	12	2013	44.35	47.04	5.77	8.57	73.44	629.42	0.87	65	0.86	0.04	0.64	0.8	0.27	0.61	23.22	25.59	27.1	-0.29	54.3	5.98
NIC	Nicaragua	12	2014	34.55	44.35	6.28	8.6	73.96	636.06	0.84	65.1	0.82	0.1	0.7	0.78	0.33	0.58	19.23	19.71	25.47	-0.39	53	5.93
NIC	Nicaragua	12	2015	34.8	34.55	5.92	8.64	74.65	644.97	0.83	65.2	0.81	0.08	0.73	0.77	0.35	0.6	20.67	18.75	23.47	-0.39	50	5.75
NIC	Nicaragua	12	2016	35.01	34.8	6.01	8.67	75.17	651.71	0.85	65.28	0.72	0.04	0.73	0.79	0.38	0.59	24.52	18.27	32.78	-0.51	49.5	5.74
NIC	Nicaragua	12	2017	35.77	35.01	6.48	8.7	75.69	658.5	0.84	65.35	0.92	0.01	0.67	0.79	0.31	0.59	28.37	17.79	32.22	-0.67	48.9	5.66
NIC	Nicaragua	12	2018	35.62	35.77	5.82	8.65	74.82	647.21	0.85	65.43	0.8	0.01	0.71	0.74	0.41	0.34	19.23	12.5	31.66	-0.7	51.4	5.71
NIC	Nicaragua	12	2019	35.59	35.62	6.11	8.6	73.96	636.06	0.87	65.5	0.88	0.03	0.62	0.79	0.34	0.51	21.63	12.98	22.55	-0.69	50.7	5.26
PAN	Panama	13	2007	53.54	53.16	6.89	9.86	97.22	958.59	0.94	67.02	0.64	0.08	0.92	0.79	0.15	0.25	58.25	48.06	24.7	0.37	22.79	3.17
PAN	Panama	13	2008	54.03	53.54	6.93	9.93	98.6	979.15	0.92	67.18	0.71	0.06	0.88	0.78	0.15	0.31	58.25	54.85	27.05	0.62	23.36	2.62
PAN	Panama	13	2009	54.34	54.03	7.03	9.93	98.6	979.15	0.91	67.34	0.72	0.01	0.89	0.84	0.14	0.6	59.33	48.33	29.4	0.37	20.37	2.95
PAN	Panama	13	2010	54.16	54.34	7.32	9.97	99.4	991.03	0.93	67.5	0.75	-0.01	0.88	0.84	0.15	0.54	59.81	47.14	29.9	0.38	20.65	2
PAN	Panama	13	2011	49.46	54.16	7.25	10.06	101.2	1018.11	0.88	67.66	0.83	0.01	0.84	0.85	0.18	0.46	58.29	48.34	30.77	0.43	19.73	1.59
PAN	Panama	13	2012	50.08	49.46	6.86	10.13	102.62	1039.51	0.9	67.82	0.78	0	0.8	0.84	0.21	0.36	63.03	45.02	30.9	0.38	21.25	3.48
PAN	Panama	13	2013	49.71	50.08	6.87	10.18	103.63	1054.98	0.9	67.98	0.81	0.02	0.81	0.86	0.23	0.42	62.56	45.5	31.82	0.36	20.71	3.38
PAN	Panama	13	2014	48.23	49.71	6.63	10.22	104.45	1067.46	0.87	68.14	0.89	0	0.85	0.8	0.25	0.44	62.98	46.15	38.3	0.37	19.78	3.94
PAN	Panama	13	2015	44.35	48.23	6.61	10.26	105.27	1080.05	0.88	68.3	0.85	-0.01	0.81	0.78	0.26	0.38	65.38	44.23	36.8	0.35	21.9	4.14
PAN	Panama	13	2016	44.42	44.35	6.12	10.29	105.88	1089.55	0.88	68.4	0.88	-0.1	0.84	0.81	0.24	0.33	61.54	35.58	33.49	0.36	22.1	4.28
PAN	Panama	13	2017	41.83	44.42	6.57	10.32	106.5	1099.1	0.91	68.5	0.9	-0.17	0.84	0.8	0.24	0.39	53.85	35.1	34.98	0.39	23.6	3.97
PAN	Panama	13	2018	42.12	41.83	6.28	10.34	106.92	1105.51	0.9	68.6	0.86	-0.13	0.84	0.84	0.22	0.28	51.44	32.69	40.19	0.36	24.44	3.29
PAN	Panama	13	2019	42.01	42.12	6.09	10.36	107.33	1111.93	0.89	68.7	0.88	-0.2	0.87	0.84	0.24	0.41	55.29	30.77	31.51	0.36	18.91	3.56
PAR	Paraguay	14	2007	34.94	35.23	5.27	9.13	83.36	761.05	0.86	64.96	0.7	0.13	0.93	0.81	0.22	0.17	19.42	8.74	16.6	-0.59	68.4	11.01
PAR	Paraguay	14	2008	34.52	34.94	5.57	9.18	84.27	773.62	0.89	65.04	0.65	0.06	0.89	0.8	0.26	0.24	17.48	16.5	19.1	-0.52	65.8	9.36
PAR	Paraguay	14	2009	35.14	34.52	5.58	9.16	83.91	768.58	0.9	65.12	0.72	0.03	0.86	0.8	0.19	0.52	19.14	22.97	21.6	-0.44	65.4	9.29
PAR	Paraguay	14	2010	43.87	35.14	5.84	9.25	85.56	791.45	0.89	65.2	0.73	0.08	0.78	0.83	0.18	0.48	18.66	25.71	24.1	-0.36	63.6	7.89
PAR	Paraguay	14	2011	44.87	43.87	5.68	9.28	86.12	799.18	0.87	65.28	0.67	0.19	0.76	0.82	0.19	0.37	20.38	24.17	31.17	-0.37	62.5	7.71
PAR	Paraguay	14	2012	44.74	44.87	5.82	9.26	85.75	794.02	0.93	65.36	0.75	0.2	0.77	0.85	0.21	0.3	21.33	20.38	31.6	-0.32	63.4	7.75
PAR	Paraguay	14	2013	44.76	44.74	5.94	9.32	86.86	809.56	0.94	65.44	0.91	0.04	0.9	0.87	0.22	0.37	21.33	14.22	30.28	-0.31	62.6	7.27
PAR	Paraguay	14	2014	44.59	44.76	5.12	9.36	87.61	820.03	0.96	65.52	0.76	0	0.76	0.88	0.22	0.19	17.31	15.38	31.59	-0.28	62.5	7.67
PAR	Paraguay	14	2015	45.01	44.59	5.56	9.38	87.98	825.29	0.91	65.6	0.81	-0.01	0.86	0.83	0.22	0.18	17.31	15.87	30.69	-0.27	60.5	7.32
PAR	Paraguay	14	2016	44.99	45.01	5.8	9.41	88.55	833.24	0.94	65.65	0.85	-0.07	0.76	0.83	0.2	0.28	20.67	26.92	28.2	-0.3	62.5	7.14
PAR	Paraguay	14	2017	46.03	44.99	5.71	9.44	89.11	841.23	0.9	65.7	0.89	0	0.81	0.82	0.23	0.38	20.19	25.96	30.3	-0.3	60.1	7.05
PAR	Paraguay	14	2018	47.39	46.03	5.65	9.44	89.11	841.23	0.89	65.8	0.88	0.03	0.88	0.79	0.28	0.21	34.62	21.63	37.23	-0.08	59.2	7.6
PAR	Paraguay	14	2019	47.43	47.39	5.42	9.41	88.55	833.24	0.79	65.79	0.51	0.06	1.09	0.82	0.22	0.31	33.17	21.63	27.09	-0.2	60.1	6.74
PER	Peru	15	2007	45.72	46.24	5.21	9.06	82.08	743.68	0.76	66.72	0.64	-0.08	0.93	0.73	0.36	0.22	35.44	50	23.5	0.28	36.1	4.49
PER	Peru	15	2008	46.29	45.72	5.13	9.14	83.54	763.55	0.78	66.98	0.64	-0.07	0.9	0.7	0.35	0.17	44.66	53.4	25.45	0.35	33.7	2.65
PER	Peru	15	2009	46.83	46.29	5.52	9.15	83.72	766.06	0.8	67.24	0.64	-0.08	0.88	0.76	0.32	0.17	41.63	47.37	27.4	0.39	32.9	4.09
PER	Peru	15	2010	46.85	46.83	5.61	9.22	85.01	783.78	0.81	67.5	0.76	-0.06	0.88	0.74	0.33	0.19	47.85	52.38	34.6	0.45	32.2	3.71
PER	Peru	15	2011	48.23	46.85	5.89	9.27	85.93	796.6	0.76	67.76	0.77	-0.12	0.82	0.74	0.33	0.29	48.34	52.61	30.34	0.46	30.6	3.1
PER	Peru	15	2012	48.96	48.23	5.82	9.32	86.86	809.56	0.76	68.02	0.7	-0.08	0.87	0.71	0.4	0.27	49.29	43.6	42.3	0.49	30.8	2.77
PER	Peru	15	2013	49.71	48.96	5.78	9.37	87.8	822.66	0.8	68.28	0.7	-0.07	0.87	0.74	0.39	0.22	49.76	41.23	35.96	0.46	28.4	2.98
PER	Peru	15	2014	50.5	49.71	5.87	9.38	87.98	825.29	0.82	68.54	0.72	-0.14	0.88	0.74	0.32	0.24	44.23	34.13	34.73	0.52	28.6	2.44
PER	Peru	15	2015	51.08	50.5	5.58	9.4	88.36	830.58	0.8	68.8	0.8	-0.09	0.88	0.74	0.38	0.18	44.23	34.62	34.87	0.49	27.4	2.66
PER	Peru	15	2016	51.55	51.08	5.7	9.43	88.92	838.56	0.8	68.97	0.83	-0.14	0.87	0.79	0.34	0.28	45.67	43.27	32.51	0.51	27.2	2.87
PER	Peru	15	2017	52.13	51.55	5.71	9.43	88.92	838.56	0.83	69.15	0.83	-0.16	0.9	0.77	0.39	0.25	48.08	38.46	32.9	0.42	27.6	3.04
PER	Peru	15	2018	52.56	52.13	5.68	9.46	89.49	846.59	0.85	69.32	0.83	-0.18	0.91	0.78	0.38	0.2	43.75	34.62	20.48	0.5	27.9	2.71
PER	Peru	15	2019	52.75	52.56	6	9.46	89.49	846.59	0.81	69.5	0.81	-0.13	0.87	0.79	0.37	0.23	49.52	35.58	32.93	0.56	27.1	3.1
URY	Uruguay	16	2007	42.99	41.48	5.69	9.69	93.9	909.85	0.87	66.86	0.79	-0.17	0.61	0.71	0.27	0.61	70.87	85.92	23.7	0.28	43.2	7.32
URY	Uruguay	16	2008	44.64	42.99	5.66	9.76	95.26	929.71	0.88	66.94	0.81	-0.15	0.6	0.68	0.26	0.59	67.96	88.35	25.7	0.26	44.1	5.69
URY	Uruguay	16	2009	45.3	44.64	6.3	9.8	96.04	941.19	0.92	67.02	0.83	-0.13	0.54	0.72	0.25	0.66	70.33	85.65	27.7	0.38	44.6	5.85
URY	Uruguay	16	2010	46.53	45.3	6.06	9.87	97.42	961.5	0.89	67.1	0.83	-0.17	0.47	0.74	0.23	0.73	70.81	86.19	31.7	0.39	53.3	5.93
URY	Uruguay	16	2011	44.76	46.53	6.55	9.91	98.21	973.24	0.89	67.18	0.85	-0.09	0.56	0.7	0.25	0.63	69.67	86.26	34.18	0.44	49.7	6.17
URY	Uruguay	16	2012	45.21	44.76	6.45	9.95	99	985.07	0.86	67.26	0.87	0.06	0.62	0.69	0.21	0.58	66.35	88.63	35.1	0.44	47.9	5.76
URY	Uruguay	16	2013	44.68	45.21	6.44	9.99	99.8	997	0.92	67.34	0.89	-0.05	0.59	0.74	0.25	0.52	67.3	89.57	38.08	0.54	51.9	5.86
URY	Uruguay	16	2014	44.41	44.68	6.56	10.02	100.4	1006.01	0.9	67.42	0.9	-0.08	0.53	0.79	0.25	0.6	71.15	89.9	34.76	0.53	56.7	6.08
URY	Uruguay	16	2015	46.1	44.41	6.63	10.02	100.4	1006.01	0.89	67.5	0.92	-0.04	0.67	0.81	0.3	0.55	71.63	89.42	35.76	0.42	59.4	6.44
URY	Uruguay	16	2016	46.86	46.1	6.17	10.03	100.6	1009.03	0.9	67.5	0.89	-0.08	0.68	0.73	0.28	0.42	72.6	88.46	34.28	0.49	60.3	6.44
URY	Uruguay	16	2017	47.36	46.86	6.34	10.04	100.8	1012.05	0.91	67.5	0.9	-0.1	0.63	0.74	0.28	0.41	69.71	87.98	34.53	0.48	60.8	6.42
URY	Uruguay	16	2018	47.31	47.36	6.37	10.04	100.8	1012.05	0.92	67.5	0.88	-0.1	0.68	0.77	0.27	0.36	73.08	87.5	34.2	0.51	60.9	6.33
URY	Uruguay	16	2019	47.5	47.31	6.6	10.04	100.8	1012.05	0.93	67.5	0.9	-0.1	0.6	0.76	0.22	0.55	74.52	88.46	43.31	0.51	60.8	6.29

Abstract in Korean

개발도상국들은 기후 변화와 자원 고갈의 영향으로부터 특히 취약할 수밖에 없다. 그건 라틴 아메리카도 마찬가지다. 이러한 경향은 앞으로 경제, 사회, 그리고 환경 면에서 중대한 결과를 초래할 수 있기에 환경과 경제 간의 관계에 대한 연구가 더욱 필요한 실정이다. 녹색 성장의 길은 자연자본을 보존할 수 있을 뿐만 아니라 지속 가능한 새로운 소득원을 촉진할 수도 있는 혁신적인 접근 방식이라 할 수 있다.

대부분의 경험적 문헌은 이러한 사안을 다루기 위해 EKC 가설을 참조했다. 본 연구는, 소득과 환경오염지표의 관계를 분석하는 다른 연구들과 달리, 오염과 관련된 종속변수를 거시경제적 지속가능지표로 대체한 수정된 EKC 의 문헌을 따랐고, 지속 가능한 개발을 유도하기 위한 틀을 구축하기 위해 녹색성장(녹색성장지수를 통해서)과 소득(1 인당 GDP) 간의 관계에 대해 검증했다.

또한 이 연구는 녹색성장에 긍정적인 영향을 미치는 결정적 요인으로 확인된 변수들을 포함했다. 이러한 변수들은 혁신, 재생에너지의 소비, 환경정책이며, 이는 개발도상국에 관한 선행문헌 및 실증연구를 따른 것이다. 국가의 역할을 평가하기 위해 공공행정과 국가 발전에 있어 중요한 요소로 여겨지는 정부의 효율성과 제도의 질이라는 두 가지 변수를 추가하였다.

이 연구의 가설은 녹색성장을 창출하는 데 필요한 가장 중요한 결정 요인으로 경제 성장뿐만 아니라 혁신(주로 환경정책의 시행에 따른 효과) 또한 녹색성장에 직접적인 영향을 미치는 결정적인 역할을 할 수 있다는 것이다. 독립변수의 유의성을 얻기 위해 임의일원효과와 시차종속변수를 사용한 패널 회귀분석 결과를 통해 가설을 확인했다. 소득과 녹색성장을 향한 혁신 간의 관계에서 긍정적이고 유의한 상관관계가 관찰되었으며, 신뢰수준은 90%였다. 재생 에너지 소비 외의 다른 통제 변수들은 녹색 성장과 긍정적인 관계를 보여주긴 했지만, 기대했던 것만큼의 의미는 없었다.

연구 결과는 특히 라틴 아메리카의 상황을 중심으로 한 국가 차원의 정책 수립과 국제 차원의 연구개발을 강화하기 위한 체제의 촉진을 위해 고려될 수 있다. 이를 통해 녹색 성장의 발전을 강화할 수 있는 좋은 관행을 장려하기 위한 협력 증가를 기대할 수 있으며, 환경 보호를 공고히 하는 동시에 새로운 친환경 수입원 창출에도 기여할 수 있다.