SCHOOL OF ECONOMICS AND MANAGEMENT

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# Green growth and poverty relations: An econometric cross-country study on lower- and middle-income countries

By

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**Abstract**

With green growth emerging as a strategy for maintaining economic growth while preventing environmental degradation, questions begin to arise on its relevance and applicability in developing countries. A prerequisite for any growth strategy in such countries is to strengthen the fight against poverty. At the same time high-cost barriers are an obstacle for the poorest economies to participate in the green development. This thesis takes an econometric perspective and examines the relation between green growth and extreme poverty levels in 61 lower- and middle-income countries from 1990 to 2019. It does so to learn whether development countries can introduce strategies that reduces poverty and simultaneously prevents environmental damage, or whether historical data implies a trade-off between the two objectives. Fixed effect regressions on OECD and World Bank data results indicate a negative long-term relationship between green growth and extreme poverty levels within the countries in this period. Upper-middle income countries seem to drive this relation, whereas the results for lower-middle income countries are weaker. This indicates that inclusive green growth is possible but has more evidence among upper-middle income countries than among the poorest economies.

# Contents

# 1 Introduction

From the British industrialization in the 19th century to the East Asian growth miracles, all historical economic growth success stories have relied heavily on environmental degradation and resource depletion (Sun et al. 2020). With the increasing knowledge on the consequences of climate change and global warming, green growth has emerged as the golden strategy to sustain economic growth in an era of environmental preservation (Smulders et al. 2014; AfDB et al. 2012). However, the question remains whether green growth strategies are applicable in the developing world. Responses to green growth in developing countries has ranged from the large emerging markets in Asia which "fathered" the concept to a general scepsis among Sub-Saharan economies (UN-DESA, 2012; OECD, 2012; Klein et al., 2013).

One reason to question green growth's applicability in the developing world, is the high-cost barriers and technological demands often seen in green sectors (OECD, 2012; Klein et al., 2013). This have led to a consensus in the literature that emerging markets are better equipped than lower income countries to successfully employ green growth strategies (Falkenhauser et al. 2013; Barbier, 2013). An example is how renewable energy sectors demands high levels of human capital and R&D capacities, which are often expensive and thus out of reach as a strategy for the poorest economies (Dercon, 2014; Barbier, 2010).

A second reason the applicability in developing countries is questioned, is since green growth strategies must be compatible with poverty eradication in these countries (e.g., Dercon, 2014; Barbier, 2016; OECD, 2013; Scott et al. 2013; World Bank, 2012). It is unquestionable that with about 40% of the population in Sub-Saharan Africa living in extreme poverty, growth models for these countries must be compatible with fighting poverty (World Bank, 2018b). Several studies has consequently argued that green growth strategies must be accompanied with poverty alleviating policies in the developing world (e.g., Jacobs, 2012; Barbier, 2016; Sachs & Someschwar, 2012). Hence it takes strong developmental states to carry through with simultaneous efforts of poverty eradication and green growth, which again questions the applicability of green growth in the weakest and poorest economies of our world (Albagoury, 2016; Schoneveld & Zoomers, 2015).

No research has yet tried to empirically examine the relationship between green growth and poverty levels through cross-country data, which is the intent in this thesis using data covering the last 30 years. Hence the thesis has two aims, namely 1) exploring how green growth and extreme poverty levels correlate over time within lower- and middle-income countries and 2) examining the difference between lower- and upper-middle-income countries when it comes to the relation between green growth and extreme poverty levels.

To this date, the literature on green growth's relevance in developing countries has mainly relied on theoretical strategies argued to be applicable in such a context (African Development Bank et al, 2012; UNEP, 2011; Scott et al. 2013; Dercon, 2014). Other research has focused on bringing forward specific examples of developing countries applying these strategies with success (e.g., Sukhdev et al., 2010; Klein et al., 2013; OECD, 2012; Casadio-Asensio et a. 2014). Although we have specific examples of successful inclusive green growth stories, there is no convincing evidence that these strategies will be applicable and alleviate poverty in most developing countries. This calls for quantitative studies covering more countries and examining the correlational patterns.

The literature lack consensus on how to define the concept of green growth, how to measure it, and on whether green growth directly encompasses social dimensions such as poverty. With new expansions of the OECD green growth indicator framework to several countries, it is now possible to explore the questions concerning the relationship between poverty reductions and green growth from a quantitative point of view. Exploring the relationships between green growth and poverty levels can help to further our understanding of whether developing countries could potentially implement green growth strategies and at the same time reduce poverty, or whether this is unrealistic considering the cost. The research question explored is: *How is green growth correlated with extreme poverty levels in lower- and middle-income countries? And, how does this correlation differ between lower- and upper-middle income countries?*

Answering these questions will contribute to uncover if the concern that green growth lacks poverty alleviating structures is generally supported by the historical developments the last 30 years. This will inform the debate on the likelihood that green growth would be successful throughout developing parts of Africa, Asia, and Latin Ameria. The quantitative generalizations will provide guidelines to whether green growth works in a trade-off with poverty alleviation or not, which will inform policymakers and researchers trying to resolve the "green growth-poverty" question. The second part of the question, exploring differences of green growth and poverty relations based on current income level, will serve to put the overall findings into perspective.

The expectations on whether extreme poverty eradication and green growth are a trade-off varies throughout the literature, mainly because green growth is an encompassing concept covering many strategies with different potentials for being pro-poor and the opposite (Sukhdev et al., 2010; UNEP, 2011; World Bank, 2012; Jacobs, 2012). However, the argument for green growth goes to claim green growth promotes economic growth (eg. Pollin et al, 2008; Zhengelis, 2012; Nordhaus, 1974; Perez, 2010). Based on these arguments, green growth is expected to averagely have negative effects on extreme poverty levels, for instance as it provides economic resources to use for poverty abatement. Hence the first hypothesis is that green growth is negatively correlated with extreme poverty levels.

As mentioned above, developing countries with middle income levels are more likely to successfully apply green growth strategies and poorer countries are more likely to experience difficulties participating in some green industries (OECD, 2012). This is for instance due to countries' different capacities to participate in the technological development and R&D processes related to the green growth strategies. Thus upper-middle income countries seem better equipped for applying green growth strategies and use its benefits to reduce poverty (Linister & Yang, 2018). The second and final hypothesis is accordingly that a possible negative correlation between green growth and extreme poverty on average is stronger in upper- than lower-middle-income countries.

The analysis is done by using the OECD green growth indicator framework, which is employed as a measure for green growth, and the World Bank's World Development Indicator database, which contains measures for extreme poverty. The empirical analysis is carried out using data on 61 lower- and middle-income countries, covering many different geographical locations (see table 5 for a full list). Through fixed effects panel data regressions, the analysis finds support for the above hypotheses. Green growth is found to be significantly related to lower extreme poverty levels within countries in the following period. Furthermore, the relation seems to be driven mainly by the upper-middle-income countries, whereas regressions carried out only for the lower-middle-income countries seems more inconclusive. This indicates that poverty abatement in general does not work in a trade-off with green growth. More research is needed to understand whether the weak results for the lower-middle income countries is due to structural features preventing countries from applying green growth or if other reasons prevent their success.

The thesis will consist of the following sections. First, the literature and theory of green growth will be explored with a focus on defining the concept, its critique, and its applicability in developing countries. This section will also cover the arguments on how green growth is expected to relate with poverty abatement. In section three the data used for the analysis will be presented, before the fourth section describes the methodology. In the fifth section, the results from the empirical analyses are presented. Finally in the sixth and final section the results and implications thereof are discussed, while also commenting on limitations and needed further advancements before the final conclusion is presented.

# 2 Theoretical foundation and literature on green growth

## 2.1 The concept of green growth

### 2.1.1 History: From sustainable development to green growth

Although the green growth concept is rather new, the idea of achieving economic growth while also meeting environmental objectives has existed for centuries under the label of sustainable development (Rische at al. 2014; Jacobs, 2012). This term (sustainable development) saw daylight in the Brundtland Report in 1987 and concerns a new paradigm where economic activity can coexist with environmental and social development (Brundtland, 1987; Rische et al, 2014). Green growth has been named a child of sustainable development. Thereby it represents a shift from a normative concept to a direct claim that growth can be green both theoretically and empirically (Jacobs, 2012). If sustainable development is the goal, then green growth is the means to get there (Rische et al., 2014).

The arising of the term green growth can be traced back to the Asia and Pacific region, where in 2005 at the Fifth Ministerial Conference on Environment and Development (MCED) in Seoul 52 governments went beyond the rhetoric of sustainable development and instead decided to aim for "green growth" (UN-DESA, 2012). This was a rhetorical shift, which sought to move beyond the decreasing focus and success in the arena of sustainable development (Jacobs, 2012). It was, however, only after the financial crisis that progressively more leaders throughout the world started applying a strategy of green growth. Finally, at the G20 Seoul Summit in 2010, green growth was acknowledged as an essential part of sustainable development (UN-DESA, 2012).

### 2.1.2 Definitions of green growth

Albeit green growth being in its infancy, it has already been vividly explored due to its political appealing nature. However, there is yet no consensus on exactly how to define green growth, and more than 13 different definitions can be identified throughout the literature (e.g., OECD, 2011; World Bank, 2012; UNESCAP 2012; Huberty et al. 2011). The definition used throughout this thesis is the one provided by the Organization for Economic Cooperation and Development (OECD), since it corresponds with the green growth indicator framework developed by the OECD, from which the data for the analysis is extracted. This definition goes: "*Green growth is about fostering economic growth and development while ensuring that the natural assets continue to provide the resources and environmental services on which our* *well-being relies. To do this it must catalyze investment and innovation which will underpin growth and give rise to new economic opportunities.*" (OECD, 2011, p.11).

The critique of this OECD definition has been as manifold as the numbers of definitions. For instance, Rische et al. (2014) argues a distinction should be made between green and greener growth, whereas the first is an absolute improvement the latter is a relative improvement. The idea is that greener growth (as they claim the OECD definition to be based upon) is only better relatively to the growth path we have today, but not itself directly good for the environment. Another criticism is that the OECD strategy excludes the social dimension, which is the final of the three pillars for sustainable development (the other two being the "economy" and the "environment") (Jänicke 2012; Rische et al. 2014). Therefore, the literature seems to agree that the definition presented by the OECD is less ambitious than for instance the one employed by the United Nations Environment Program (UNEP). Whereas the OECD represent "weak green growth" the UNEP stands for "strong green growth", with a contrast on whether the environment and growth is believed to work in a trade-off or not (Smulders et al., 2014).

In short, the ambition of green growth is to ensure economic growth without environmental degradation and depletion of natural resources. Furthermore, it is debatable whether social aspects such as reducing poverty and inequality are an inherent part of the ambition as well. Although this thesis employs the OECD definition of green growth it does include a part of the social dimension, as it explores the relation between green growth and poverty. The applied idea of green growth in this thesis is that the social dimensions are of utter importance for the success of green growth. Yet when using the term "green growth" it will refer to only the economic and environmental dimensions.

### 2.1.3 Theoretic framework of green growth

The standard argument for green growth is presented in the Stern Report on the economics of climate change (Stern, 2007). It goes to claim, first that the costs of preventing environmental damage does not completely nullify economic growth, and secondly that if environmental damage is not prevented, this will hurt economic growth even more than preventing it (Jacobs, 2012). This exemplifies a cost benefit analysis, where preventing environmental damage was found better for economic growth in the long run than not preventing it. However, the argument has been contested especially on how costs are estimated. Critics such as William Nordhaus, argues that benefits on such a long-term does not compare to the size of present costs. Especially when future societies will be richer and more technologically developed and therefore better able to adapt or prevent global warming (Nordhaus, 2007). This has sparked a rather huge debate on how to discount future benefits and costs (Mosely, 2001; OECD, 2006; Farber & Hemmersbaugh, 1993).

The criticism gave base for a much stronger argument for green growth. The argument claims that environmental protection can be more than just compatible with economic growth: it can even promote it (Jacobs, 2012). The theories underlying this argument are threefold. The first argument, was a green Keynesian short-term argument that environmental stimulus could restart the economy after the recession in 2008. The idea is that green government investments replace the lacking private sector demand in times of crisis. Thereby economies can be stimulated back into growth (especially employment growth) through measures aimed at improving the environment (Pollin et al, 2008).

Investments into renewable energy, public transport, or pollution control can get people back into work and increase demand for green goods and services (Zhengelis, 2012). Some even argue that green sectors are better than others in regards to short term growth since many environmental measures are labor intensive (Engel and Kammen, 2009). In fact, many stimulus packages following the financial crisis did indeed entail green programs, but the critique of the core idea of Keynesian stimulus is also quite elaborate. Generally, the claim is that this government stimulus is ineffective in creating jobs and merely crowd out public investments (Jacobs, 2012).

The second theoretical backing is derived from core economic theory of correcting market failures. Here, the natural environment is viewed as a production factor, which has been ignored to this date (eg. Nordhaus, 1974; Solow, 1974). The natural environment is defined as capital as it provides resources, assimilates waste, and is used to provide environmental services. The argument is that natural capital has been undervalued and thereby led to market failures due to overexploitation of common goods. Because of this, the current growth path is believed to be sub-optimal, thus growth will increase if the market failure is corrected (Jacobs, 2012). However, the critique of these arguments are many, especially when the industrialization process of most developed countries prove that economic growth tends to be correlated with higher environmental degradation. Ie. from an economic perspective it does not seem sub-optimal to be environmental harmful. However, the counter argument to this is that "brown growth" (growth that is environmental degrading) used to be optimal, but since natural resources are scarcer today it has become sub-optimal (Rockstroem, 2009).

The third and final theoretic argument is on comparative advantages and technological revolutions, which are enhanced through innovation and industrial policy. Here, it is believed that environmental policies can create jobs in the environmental industry and thereby enhance growth. This relies on an assumption that these sectors can create more jobs than so called “brown sectors” like coal mining. The theory behind this assumption is that there is a first mover advantage (comparative advantage) because many of these sectors are not yet fully exploited. Examples of this is the wind turbine sectors in Denmark, and solar energy sectors in China (eg. Brandt & Svendsen (2006); Fang et al. (2018); Chiu (2017)). Secondly, the related argument is that we are approaching a new industrial revolution, with low carbon energy systems and environmental technologies that will enable an economy with a much lower environmental impact (Perez, 2010). However, critics argue that green growth will fail if it relies on governments to act as entrepreneurs in guiding a new industrial revolution (Winston, 2006).

#### 2.1.4 Empirical evidence for and against green growth

One thing is theoretical arguments, another is the historical data. The green growth debate is based on the historic data showing that when developed countries experienced economic growth, their carbon emissions and resource usage increased immensely. So while the world GDP has risen from 11.36 to 84.85 trillions constant 2010 US$ (increase of approx 647%) between 1960 and 2019, the global carbon emissions has also risen from 9.2 to 33.8 million kt (World Bank, 2019a; World Bank, 2019b). The underlying idea of green growth is that this relation is not causal but avoidable. I.e., by relying on new sources of economic growth we can decouple economic growth from carbon emission and resource usage and thereby accomplish green growth that does not cause harm to the environment.

However, not everybody believes this decoupling is possible. A whole range of literature has emerged around the concepts of “degrowth” or “zero-growth” with the claim that the only way to avoid environmental degradation and climate disasters is to stop aiming for economic growth (eg. Hickel & Kallis, 2020; Kallis, 2011). Hickel & Kallis (2020) find no empirical evidence which supports green growth, i.e., no evidence of absolute decoupling from resource use and economic growth on a global scale. Furthermore, they find that absolute decoupling from CO2 emission is not likely to happen fast enough to prevent global warming above the 2-degree target.

On the other hand, it is not difficult to find evidence of some degree of decoupling. One is the European Union’s ability to cut carbon emissions by 22% between 1990 and 2017 while the economy grew by 28% (Jackson & Victor, 2019). However, this figure is also simplified as the European Union during the same period outsourced large amounts of emission to developing countries (Peters et al., 2012). The debate on emission outsourcing is an even more complicated matter and according to others the EU are still decoupling although outsourcing (Baumert et al., 2019).

What is important for the aim of this thesis (exploring green growth and poverty relations), is whether there is basis for believing green growth is both possible and economically beneficial. Based on the theoretic arguments above, green growth is expected positive for economic growth. And with economic growth as a prerequisite for poverty eradication, green growth should thus be expected positive for poverty eradication. Hence the blurry empirical evidence of green growth should not weaken our theoretical expectations. Furthermore, the descriptive analyses will touch upon the extent to which green growth has on average occurred within the 61 lower- and middle-income countries of this thesis.

## 2.2 Green growth in developing countries

Although the idea of green growth is both appealing and theoretically plausible, questions remain regarding its applicability in the developing world. In fact, the possibilities of green growth are even more important in the developing world, as they are in need of experiencing economic growth, which done the usual way will lead to immense global emission increases (World Bank, 2012). Furthermore, developing countries are generally placed in some of the areas most vulnerable to climate change (Margulis et al. 2009; Klein et al., 2013). Hence the relevance of green growth for the entire world relies on its applicability in the developing world (OECD, 2012).

### 2.2.1 What is meant by "developing countries"?

The phrases used in the literature to divide countries based on their economic development level are many (Perkins et al., 2013). In this thesis, "developing countries" is used as a way to divide countries based on their income level. The reason for this being that prospects for economic growth are immensely affected by the previous growth trajectories and thereby current income status. The thesis employs the four-part income level classification invented by the World Bank based on gross national income (GNI) per capita levels in current USD (Serajuddin & Hamadeh, 2020):

- Low-income countries (LICs): Average GNI beneath $1,036
- Lower-middle-income countries (LMICs): Average GNI between $1,036 and $4,045
- Upper-middle-income countries (UMICs): Average GNI between $4,046 and $12,535

- High-income countries (HICs): Average GNI above $12,535

In an economic paradigm where economic growth is the aim, we assume the goal of development is reaching high-income status. By this definition, the closer to having a GNI above $12,535 the more developed a country is. So, when referring to "developing countries", this thesis refers to LICs, LMICs, and UMICs, as they are in this paradigm developing toward HICs. At times this thesis will use the term "emerging economies/markets", which is common throughout the literature, but has different definitions (Dabrowski, 2020). When the term is applied here it generally refers to middle income countries (mainly UMICs) which have experienced great growth potentials throughout the latest decades. Examples are the BRICS countries and second tier South-East Asian newly industrializing economies (e.g., China and Indonesia). However, due to the lack of a single empirical identification, an effort will be made to translate insights on emerging markets into effects related to the income level groups.

### 2.2.2 The response to the concept in the developing world

The responses to the concept of green growth from developing countries have been diverse. On the one hand emerging economies describe the positive factors and opportunities offered by green growth very enthusiastically, since many of these economies have access to the proper funding and technology to exploit the opportunities created (OECD, 2012).

On the other hand, many lower-income countries express caution. Only a few countries are reacting directly to the concept, but there is concern that the technologies and policy ideas are not relevant nor accessible at their developmental stage (Klein et al., 2013). More specifically two critical issues have been expressed. One is whether green growth properly addresses poverty and other development priorities. For instance the inclusion of the informal industry through green growth strategies is a prerequisite. Secondly, there is a concern that green growth efforts will be impeded by high-cost barriers. Green growth tends to rely on advanced technology that is very costly and therefore out of reach for developing countries. This fuels a concern that these technologies will push out the existing indigenous technology and make them dependent on imports (OECD, 2012).

In Sub-Saharan Africa, the concept has lacked general awareness, but a few countries have implemented green growth strategies (e.g. South Africa and Ethiopia). Especially Ethiopia is a country that has seen and defended the potentials of green growth. The prime minister of Ethiopia has gone to say that "*Africa is in a good position to shift to GE [green economy] and to use the economic potentials resulting from G*E" (Klein et al., 2013, p. 12). However, a general critique from the African perspective is that green growth is just another form of (eco)protectionism from the developed world (Klein et al., 2013).

### 2.2.3 Potential benefits for the developing world

There are theoretical arguments both in favor of and against the applicability of green growth in developing countries. On the positive side, many developing countries have not yet created the expensive "lock-in" decisions (e.g. on the electricity grid) that the industrialized countries have (OECD, 2012; World Bank, 2012; Klein et al., 2013). In the long run it will be cheaper for the developing world to implement the new and cleaner technologies from the very beginning of their industrialization, rather than cleaning up afterwards as other parts of the world are doing (Klein et al., 2013).

The list of potential benefits of green growth in developing countries is extensive. One benefit is to avoid the costs of environmental degradation, which is generally perceived higher in developing countries than the global average, as they are more vulnerable to climate change (Margulis et al., 2009). Another benefit is the potential for renewable energy as for instance solar energy in Africa, which both creates job opportunities, economic development, and long-term energy security. Green growth in developing countries also beneficially involves giving large parts of rural areas access to modern energy and pushing the economic transformation through electricity generation and energy resources. Furthermore, green growth strategies enhances preservation and protection of the natural capital which is vital to many industries in developing countries (Klein et al., 2013).

An important note on green growth's benefits for the developing world is that the current global economic system is increasingly considered inequitable in its distribution of benefits and costs (OECD, 2012). Therefore, an argument is that to the poorest economies, this green growth paradigm cannot be worse than the existing one. As growth is necessary for the developing world, talking of degrowth is not viable. Due to these facts, searching for a green growth strategy is beneficial for developing countries (World Bank, 2012).

### 2.2.4 Barriers to green growth in developing countries

First and foremost, about the barriers, some researchers have argued that the green growth concept requires a structural transformation, entailing that most green growth policies are more applicable in higher-income countries and large emerging markets (Falkenhauser et al. 2013; Barbier, 2013).

Other notable strands of literature have argued that in order to be relevant in developing countries, green growth must be compatible with the key structures of these countries, and thereby be compatible with natural resource dependency and poverty alleviation (Barbier, 2016). The general saying in the literature has been that green growth cannot guarantee poverty alleviation, and hence must be followed directly by policies aiming to reduce poverty (eg. UNEP, 2011; Barbier, 2010; Barbier, 2014; Bass et al, 2016; Dercon, 2014). This is a barrier in general for developing countries, especially when the governance and policy environment lack the needed strength to achieve even simpler policy objectives (Schoneveld & Zoomers, 2015).

Other barriers are the lack of human capital, and well-functioning political constitutions to carry out the strategies in a proper manner. The latter is particularly problematic with green growth, as it is a multidisciplinary approach that requires close cooperation between different governmental levels and scientific areas, and that the platform for this cooperation is in place (Klein et al., 2013).

Another barrier for countries facing a lot of difficulties, seems to be the urgency of fixing more immediate problems first. For many developing countries, issues with poverty, poor sanitation, malnutrition, educational attainment, etc. need to be solved as soon as possible. Most often solving these issues are seen as contradictory to implementing green growth, due to which the latter is pushed back in line and not prioritized (Klein et al., 2013).

### 2.2.5 The literature on green growth in developing countries

What is evident in the literature is that the focus of green growth in developing countries have been threefold. First, many studies are concentrated on the theoretical applicability of green growth in developing countries (e.g. Scott et al. 2013; Dercon, 2014). Second, another strand of studies has focused on developing strategies of green growth that can be applied in developing countries (e.g. AfDB et al, 2012; UNEP, 2011). Third, a strand of literature has focused on exploring case examples from developing countries where the strategies have successfully been employed (e.g. Sukhdev et al., 2010; Klein et al., 2013; OECD, 2012; Casadio-Asensio et a. 2014). Theses focuses makes sense due to the infancy of the literature field. It has been important to first understand the theory, develop the strategies, and give examples of the strategies initiated to even talk about green growth in developing countries.

But the chosen focus also reveals a rather large gap in the literature: to explore the quantitative relations of green growth. As the concept has evolved with available data, it is now possible to measure the concept empirically and thereby explore patterns and possible generalizations derived from the theory. This thesis tries to tap into is this gap, by empirically exploring the relation between green growth and poverty. With the theoretical backing and strategies in place, it is now time to explore what real life data says on the matter in a macroeconomic perspective. This may give more generalized answers to questions than the descriptive case studies of the current literature. So instead of going too deep into the interesting descriptive cases that exist, the focus of this thesis is to elaborate on the theoretical expectation of the green growth and poverty relation.

## 2.3 Green growth and poverty

### 2.3.1 Equity within and between countries

As clarified above, to be relevant for developing countries green growth must be able to alleviate poverty in these countries, as that is a major focal point here. Furthermore, empirical evidence of relations between the concepts of poverty and green growth have been found to be lacking and still unexplored. As with "normal" growth, there is no doubt that green growth can be applied with or without equity. In short, green growth must be inclusive such that it reconciles the developing world's urgent need for economic growth and poverty alleviation while preventing irreversible and environmentally costly damage (World Bank, 2012).

Green growth has already sparked rather much discussion on the matter of equity between countries as well (Sahchs & Someschwar, 2012). Equity has been acknowledged as a necessary element of green growth, especially due to the different circumstances between countries when it comes to climate degradation, which has come to be phrased as *common but differentiated responsibilities*. This refers to the large difference on historical environmental degradation such as carbon emissions. However, the earth's atmosphere is global and affects everybody regardless of who is responsible for the emission of CO2 (Sahchs & Someschwar, 2012).

### 2.3.2 Green growth and poverty relations

Mentioning poverty and growth without talking of inequality is impossible, as these three concepts are intertwined. Poverty alleviation depends on economic growth, but also on the distribution of this growth. Inequality levels further impacts growth, as it determines the share of the population which can actively participate in the economic activities in the country (Iradian, 2005). These different relations have been gathered into the concept of the "inequality-poverty-triangle" (Perkins et al., 2011).

The important understanding is, that growth can both be pro-poor and not. The most common example of pro-poor growth is economic growth based on labor intensive industries, which is favorable to the poor, as their labor skills are seen (economically) as their primary asset (Perkins et al., 2011). It must be emphasized that this thesis focuses on absolute poverty in terms of material deprivation.

When turning towards green growth, its relation to poverty depends on which green growth strategies are employed (Sukhdev et al., 2010). This is also why the World Bank (2012) states that green growth can be both pro-poor and not. On the positive side, many green growth sectors, such as the renewable energy sector, tend to be labor-intensive after the technology itself is imported. A UNEP report also argues that since many of the natural resources in developing countries are controlled by the poor, the actions to conserve and enhance productivity of these resources will be poverty-reducing and growth-enhancing all at once (UNEP, 2011; Jacobs, 2012).

In fact, an entire literature field has emerged on the concept of inclusive green growth (eg. World Bank, 2012; Sun et al. 2020; Albagoury, 2016). In Albagoury (2016) inclusive green growth is explored through a case study in Ethiopia, with the conclusion that their inclusive green growth strategy had not been very inclusive. Schonevald & Zoomers (2015) exploriation of inclusive green growth in Sub-Sharan Africa found that it demands a strong developmental state to achieve inclusive green growth and leave old development trajectories behind. This is one reason, why it might be difficult for lower income countries to achieve inclusive green growth, as they generally are perceived to have weaker developmental states (Schonvel & Zoomers, 2015). But again, this literature has stranded at describing strategies to achieve inclusive green growth, considerations on how to measure it, and case examples to evaluate it (eg. Banda & Bass, 2014; Sun et al, 2020; Narloch et al. 2016).

Another strand in the literature argues against green growth being per se inclusive (eg. Jacobs, 2012; Barbier, 2016). This is since green growth might be costly in the short term and thereby uptake government spending, that could otherwise be used for poverty alleviation (Jacobs, 2012). Further studies concludes, that green growth must be accompanied with specific policies targeting poverty, as green growth per se does not ensure this (Barbier, 2016; Sachs & Someschwar, 2012). Final arguments is that the poor is unlikely to be favored in green growth strategies, thus it is difficult to promote equitable income growth that reconciles with environmental protection (Ota, 2017).

### 2.3.3 Theoretical expectations

In conclusion of the literature and theoretical outset it is quite difficult to single-handedly point out how and if green growth will necessarily affect poverty or whether these are two different policy objectives. This inconclusiveness makes it highly relevant to explore this relationship empirically. However, it also makes it difficult to make a clear-cut theoretical expectation. As this thesis explores correlations over time and not causalities, the importance is not the fear above that green growth does not bring poverty eradication directly, the importance is whether green growth and poverty eradication is happening sequentially.

Although some green growth strategies might crowd-out poverty initiatives it seems questionable that green initiatives should directly increase poverty. The effect of green growth on poverty thus is expected to be negative (higher green growth entails lower extreme poverty - hypothesis 1) as green growth is argued to produce economic growth, which further is argued to reduce poverty. Hence green growth is expected to make poverty alleviation possible.

When it comes to the second hypothesis on differences between upper- and middle-income countries, the theory seems to indicate that upper-middle income countries will most likely be better equipped to take on the strategy of green growth. Even more so, it seems that poverty alleviation through green growth demands relatively strong developmental states which are generally greater among UMICs than LMICs. Consequently, the theoretical expectation is that the negative relationship between green growth and poverty is stronger for the UMICs than the LMICs (hypothesis 2).

# 3 Data

Before going into the methodology and analysis the data explored must be understood. The following section will present the two different indicator frameworks where data is extracted from. Firstly, the OECD Green Growth Indicator Framework, from which the green growth indicators have been extracted. Secondly, the World Bank World Development Indicators from which the poverty measure and control variables have been extracted. The section will be finished off commenting on the work with the data.

## 3.1 OECD Green Growth Indicator Framework

The OECD Green Growth Indicator framework was first published in 2011 and has since then been further developed to expand both in numbers of indicators, dimensions of the concept, and coverage of world countries (OECD, 2011; OECD, 2014; OECD, 2017). The framework was initially created due to the increasing focus on the concept of green growth. This demanded for better ways to monitor green growth progress and strategies in order to better guide policy makers with internationally comparable data.

Originally the data only covered the OECD countries, but today it covers most countries worldwide with a varying degree of completeness. The framework was developed to reflect the multidimensionality of the green growth concept, as they deemed that the process cannot be captured by a single measurement. The indicators are meant to enable monitoring the progress towards four objectives: "*establishing a low-carbon, resource-efficient economy; maintaining the natural asset base; improving people's quality of life; and implementing appropriate policy to realize the economic opportunities of green growth.*" (OECD, 2017, p. 16).

With these four objectives in sight, a framework consisting of 26 indicators was developed by the OECD in a database. They have divided the indicators into four main areas: 1) Economic opportunities and policy responses, 2) Energy and resource productivity, 3) Natural asset base and 4) Environmental dimension of quality of life. Furthermore, indicators on the socioeconomic context were included to complete the indicator framework (OECD, 2017). A list of the five areas, and further division into sub-areas is illustrated in table 1.

In addition to the extensive indicator list, the OECD acknowledges the need for more simple ways to communicate and monitor the process to policy makers and the general public. Hence the OECD has also developed a list of six headline indicators, they perceive as the central elements of green growth. This list is to be further developed and always open to changes for the context and purpose of the specific use (OECD, 2014; OECD, 2017). The list of headline indicators chosen by the OECD is included in table 2, as these have guided the choice of indicators used in this thesis.

For this thesis' analysis seven indicators were chosen from the framework to construct a composite indicator of green development which will be elaborately described in the methodology. The considerations in the selection process were based on the importance of the indicator for green growth (guided both by the headline indicators, but also the specific context of low- and middle-income countries and the focus on poverty), the aim to get most possible dimensions represented, the cross-country comparability, and the data availability.

The final seven indicators selected to be applicable for the research are: *CO2 productivity, energy productivity, renewable energy share, non-energy material productivity, green patents, temperature changes, and environmental pollution.* The first four consist of different areas in the dimension of energy and resource productivity. It was chosen to have many indicators

Table 1: OECD Green Growth Indicator Framework

| Dimension | Sub-area |
|---|---|
| Economic opportunities and Policy Responses | Environmental Taxation and Transfer |
| | Technology and Innovation: Patents |
| | Technology and Innovations: R&D |
| | Regulation and Management |
| | International financial flows: Official Development Assistance (ODA) |
| Energy and Resource Productivity | CO2 productivity |
| | Energy Productivity |
| | Non-energy productivity |
| | Environmentally Adjusted Multi-factor Productivity |
| Environmental Dimension of Quality of Life | Exposure to Environmental Risk |
| | Access to drinking water & sewage treatment |
| Natural Asset Base | Freshwater Resources |
| | Land Resources |
| | Forest Resources |
| | Wildlife Resources |
| | Atmosphere and Climate |
| Socioeconomic Context | Economic context |
| | Social context |

Table 2: OECD Headline Indicators

| Dimension | Sub-area | Headline Indicator |
|---|---|---|
| Environmental and resource productivity | Carbon and energy productivity | CO2 productivity |
| | Resource productivity | Non-energy material productivity |
| | Multifactor productivity | Environmentally adjusted multifactor productivity |
| Natural asset base | Renewable and non-renewable stocks | Natural resource index |
| | Biodiversity and ecosystems | Changes in land cover |
| Environmental quality of life | Environmental health and risks | Population exposure to air pollution (PM2.5) |
| Economic opportunities and policy responses | Technology and innovation - Environmental goods and services | *Placeholder: no indicator specified* |
| | Prices and transfers - regulations and management approaches | |

from this dimension, as it is the most evolved dimension and the most represented among the headline indicators chosen by the OECD. Each of the other three dimensions, are represented solely through one indicator, and thereby only representing one of the different sub-areas. The green development composite indicator based on these seven indicators, will thus particularly depend on the dimension of environmental and resource productivity. Hence any improvements made in other dimensions will not count as much towards countries' green development measure. This is limiting the multidimensional concept somehow. This thesis can merely be used to look at these specific dimensions of green growth and is not attempted to be generalized to the further dimensions.

Finally, besides these environmental measures, the GDP growth must also be included in the analysis. When computing a green growth indicator (described in the methodology section) both the green development indicator and GDP growth need to be included. This measure is included in the economic context, and therefore also available through the OECD indicator framework.

## 3.2 World Bank World Development Indicators

Poverty, however, is not included in the indicator framework. To measure poverty, this thesis uses the World Banks World Development Indicators, which consists of more than 1400 time series indicators for 217 economies and some data dating more than 50 years back in time proving its large data coverage and international comparability (World Bank, 2021b).

The World Bank applies three different thresholds for extreme poverty: income levels below \$1.9, \$3.2, and \$5.5 (in 2011 purchasing power parity) a day. Having these three international poverty lines (IPLs), was introduced by the World Bank in 2018, to acknowledge the global change from the majority of world population living in lower-income countries (LICs) to today living in lower- and upper-middle-income countries (LMICs and UMICs). When the IPL was traditionally introduced, 60% of world population lived in LICs, today this number is only 9%, whereas 41% lives in LMICs and 35% in UMICs (World Bank, 2020). The two new poverty lines therefore reflect extreme poverty in LMICs (\$3.2 a day) and UMICs (\$5.5 a day) to complement the threshold for LICs (\$1.9 a day) (World Bank, 2020, p. 29). The revision was based on new calculations of PPP exchange rates, and averages of national poverty lines of countries in the different income statuses (World Bank, 2018a, p. 67-85; Jolliffe & Prydz, 2016.).

International poverty lines have been criticized by various sources, first and foremost due to the arbitrary nature of the concept. If if you have \$1.9 a day in LICs one is extremely poor, but not if you have \$1.95 (Perkins, et al. 2006, p. 180-190). This essentially means lifting people's income just \$0.1 dollar a day can improve poverty measures drastically, and leaves incentives to focus on population near the threshold. This is an inevitable nature of thresholds, but another discussion is on the choice of the thresholds itself. Here economist Angus Deaton has argued that the \$1.25 IPL is too high (the LIC threshold use to be \$1.25) and a weighted average of national poverty lines should be used instead (Deaton, 2010). Meanwhile Lant Pritchett argued that it is way too low, and a global poverty line should be \$15 a day (Pritchett, 2003). This indicates the arbitrary nature of the line itself, but IPLs serves some justification in a research on cross-country data, as it is one of the acknowledged ways to compare data on poverty between countries. It is acknowledged that IPLs does only capture the degree of material deprivation as a measure of extreme absolute poverty, and therefore does not account for the multi-dimensions of poverty. Meantime, in an empirical assessment as this, it was chosen to be the most applicable way to explore effects on poverty.

It should be mentioned, that the control variables used for the regression analyses are also obtained from the World Bank's World Development Indicator framework. This ensures compliance in the methodology for the variables as well as comprehensive data coverage.

## 3.3 Data handling

The OECD indicator framework includes data ranging from 1990-2019. However, for the first 20 years, data is only provided on a five year basis (i.e. for years 1990, 1995, 2000, 2005, and 2010), for the last 10 years it has been reported annually. This lay ground for considering making six five-year panels for the analyses. This was also applicable, as some lag in the effect of green growth on poverty is expected - as green growth one year might first really have effects on poverty in the years to come. Due to this, it was chosen to compute six five-year panels (1990-1994, 1995-1999, 2000-2004, 2005-2009, 2010-2014, and 2015-2019), which have also been done in other empirical research (e.g., Wei & Hao, 2010; Bloom & Finlay, 2009; Bloom, Canning & Malaney, 2000).

For each period poverty, green indicators, and control variables (see methodology section) are measured as the average of the five-year span. GDP growth is measured as the growth over all five years. A note here, is that for the first 20 years (ie. first four periods), the green indicators are in fact not means, but measured as the initial year, because no more data was available as mentioned above. It was still chosen, however, to apply the means for the last two periods to utilize all available data.

As mentioned the thesis focuses on middle-income countries, but low-income countries are also included in some parts of the analysis. In total 61 countries from mainly Latin America, Africa and Asia have been included in the analyses, from which 29 are UMICs, 27 are LMICs, and 5 are LICs. The countries were chosen mainly based on data availability. A full list of the countries can be found in table 5 which reveals basic descriptive statistics of the key variables for each country.

Inclusion of both UMICs, LMICs, and LICs are advantageous for the empirical regressions, since a T=6 demands a high number of countries to have enough observations to conclude anything from. Focusing on middle-income countries favorably allows for a division into UMICs and LMICs. The income level groups are established using countries' income status in 2019. This decision to use current income statuses affects results, since some countries have moved from one income group to another. An example is China, which in 1990 was a LIC, but in 2019 was an UMIC. Therefore, the UMICs also represent the income level of growth success stories opposite to LICs which have not been capable of raising their income levels substantially. This is expected to impact the results on the comparisons between UMICs and LMICs, but this will be touched upon after providing the results.

# 4 Methodology

## 4.1 Research design

Taking the outset in the theory of green growth and the aim of exploring its relation to poverty, the thesis is based on a deductive approach. Moreover, it can be characterized as a quantitative research with a longitudinal design. This is feasible due to the purpose of empirically studying whether green growth affects poverty levels. Therefore, the research is executed as a correlation study. This must be emphasized, as the aim is to explore whether these variables that we can theoretically expect to affect one another, also seem to do so over time. This will allow for a better understanding of how these components interact, it will, however, not be able to state causality. This is due to the lack of predeceasing assessment, and this study therefore aims to make initial correlation studies that might push for more causality studies in the future.

## 4.2 Composite indicators

A composite indicator is a way to measure a multidimensional concept in a way which is easier to interpret and compare across countries, than using independent indicators for each dimension (Saltelli, 2007). A composite indicator can be formulated in the following manner: "*A composite indicator is formed when individual indicators are compiled into a single index on the basis of an underlying model*" (Nardo et al, 2005, p. 13).

The use of composite indicators is, however, vividly debated as some scholars deem it good and others bad per se (Sharpe, 2004; Saisana et al., 2005). The applicability of using composite indicators lie in the intended purpose (Nardo et al., 2005, p. 14). However, one must be aware of the pros and cons of using such simplification. Some positive aspects are that it can summarize multidimensional and complex realities, can guide policy-makers, is easily interpreted, and reduces the number of indicators without completely dropping the underlying information the various indicators have. On the negative side they can mislead the policy messages and conclusions when poorly constructed, can be too simplistic, can be subjective in the choice of indicators and weighting, and can thus be misused for political purposes or generally to get forward the message you seek (Saisana & Tarantola, 2002). These pitfalls, is not against the use of composite indicators but calls for cautiousness when computing it.

The idea of creating a green growth composite indicator, is grounded in the theoretic framework created by the OECD, which emphasize how these dimensions together represents green growth (OECD, 2011; OECD, 2014; OECD, 2017). The OECD themselves, avoided creating a composite indicator, because they deemed the indicators should be handled and chosen based on the purpose and national context (OECD, 2014). The choice of indicators for the context this thesis was described in the data section.

All variables were standardized, in order to not let any of the indicators matter more than others. Furthermore, all variables were created such that the higher the value, the better for the environment. This entails changing the scale for pollution and temperature changes, so they instead measure the clean air and lack of temperature changes by multiplying the values by -1. As the underlying framework emphasizes the importance of all dimensions, the indicators were aggregated and weighted equally Therefore the indicator is as follows:

$$GD_{it} = \frac{pat_{it} + pollu_{it} + tempc_{it} + co2prod_{it} + enerprod_{it} + renewener_{it} + matprod_{it}}{7}$$

This is the green development indicator, which is an overall measure of environmental improvements. It ensures that if a country improves on one measure but worsens on another the effect cancels out. It requires overall improvements to get an increasing green development score. One could argue that the different indicators might not have the same implication for poverty and/or growth, due to which they should not be weighted equally. There is, however, no clear expectation which should matter most for poverty, hence they were chosen to be weighted equally, such that no normative choice is made about what green improvements are better than others.

The green development indicator only includes the environmental measures, whereas a green growth indicator must also include the economic dimension. It was chosen to compute the green growth indicator by simply adding the green development score to the GDP growth over the five year period after both variables had been standardized in order for them to impact equally on the final green growth score. I.e. the green growth indicator is as follows:

$$GG_{it} = GD_{it} + GDPgrowth_{it}$$

This creates an indicator where green development works as an adjusting factor to GDP growth, such that GDP growth in times of positive green development is perceived better than GDP growth in times of negative green development. It is possible to get a positive green growth score while having a negative green development score as long as the GDP growth is high enough. In regards to the theoretical debate, this is therefore a measure of *greener growth*. To understand which directions each of the two inputs (GDP growth and green development) is pulling the overall green growth score in, the analysis will run the regression using these two variables as individual predictor variables as well.

## 4.3 Fixed Effect Model

The longitudinal cross-country study provides a panel data structure, which one must be cautious of. In this case, various time-invariant factors might create differences between the countries. Meanwhile country invariant factors might create time differences. In other words, there is a risk of omitted variable bias when running simple regressions on panel data. One way to limit this risk is through a fixed effect model. The purpose is that we can group the unobserved factors into two different groups; one that varies over time, and one that does not vary over time. By denoting the cross-sectional unit by $i$ and the period by $t$, the model can be written as the following:

$$y_{it} = \beta_1 x_{it1} + \beta_2 x_{it2} + \ldots + \beta_k x_{itk} + a_i + u_{it}$$

where there is $k$ explanatory variables, $a_i$ is the time invariant unobserved effects and $u_{it}$ is then the time-variant unobserved effects. I.e. we get two error terms compared to the simple model with only one error term. The idea of including $a_i$ is that we might expect poverty levels to be affected by where the country is situated. Therefore, the intercept of the regression is expected to differ between countries, as we would not expect the same poverty level across countries although all explanatory variables were the same. By including $a_i$ we allow for countries time invariant factors to affect their poverty level, without identifying a long list of these and directly control for them in the regression. Instead, the fixed effect model allows one to directly account for these differences and explore the effect of green growth on extreme poverty levels within countries. One shortcoming then, is that one cannot include time-invariant factors explanatory or control variables, as they will go into the time invariant error term. For instance, we cannot include a dummy of income level status, and thereby see if this has an effect.

The assumptions needed for the fixed effect model to produce unbiased estimates are several. First, we must make the strict exogeneity assumption; that entails all explanatory variables must be uncorrelated with the time-variant error term $u_{it}$. We do however, allow for the explanatory variables to correlate with the time-invariant error term, $a_i$. The data was tested using the Hausman test, to see whether a random or fixed effect model should be used, and this supported the choice of using the fixed effect model. Secondly, the error terms $u_{it}$ must be homoscedastic and serially uncorrelated. Using the modified Wald test on the data indicated heteroskedasticity which was corrected for by using heteroskedasticity robust standard errors through all regressions. Serial correlation is not considered problematic when working with a low amount of time periods as T=6 is. In sum, the fixed-effect model seems to match the data structure, and thereby provide a solid basis for obtaining useful regression results.

### 4.3.1 Control variables

Although the model seems promising, to obtain unbiased estimates, it is important to control for confounding factors between green growth and poverty in the regressions. Several factors besides green growth affects poverty levels and green growth, due to which they need to be included to avoid finding spurious relations between green growth and poverty. This list of controls is: educational attainment, government consumption, population size, inequality levels, degree of urbanization, and total GDP. This reflects general procedures from similar research in the literature (eg. Huang & Quibria, 2013; Dollar et al., 2015; Moser & Inchida, 2001; Sun et al. 2020; Grunewald & Martinez-Zarzoso, 2015; Barro, 2000; Lopez & Servén, 2019).

Controls are also all lagged, in order to ensure they are not outcomes of the predictor variables. Because the regression will be done using time lags for all predictor and control variables, poverty in the previous period will be included to control for time trends (Woolridge, 2016). Furthermore, in addition to the main model tested, which is presented below, regressions will also be done using period-fixed effect (country-invariant time-variant) in addition to the country fixed effects in the original model. This controls for confounding factors through the specific periods. For instance this will control for the period 2004-2009 having a global economic crisis affecting both poverty levels and green growth measures in all countries.

### 4.3.2 Model specifications

The specific models, which will be run in the analysis, is (1) one with green growth as predictor variable, (2) one with green development and GDP growth as predictor variables, and finally (3) one with all green growth indicators as predictor variables. Furthermore, these two models will be run once for UMICs, once for LMICs, and once for both LICs, LMICs, and UMICs. This presents a total of 6 regressions with the main models, to which six similar regression are added which only difference is that they contain period-fixed effects to robustness check the results. For simplicity in the model specification below the control variables are presented using the following vector notation

$$\boldsymbol{controls_{i,t-1}} = (educ_{i,t-1}, govcon_{i,t-1}, gini_{i,t-1}, pop_{i,t-1}, urban_{i,t-1}, pov_{i,t-1}, GDP_{i,t-1})$$

$$\boldsymbol{\beta} = (\beta_{p+1}, \beta_{p+2}, \ldots, \beta_v)$$

where $v$ is the total number of variables included in the regression (excluding the outcome variable) and $p$ is the number of predictor variables. By using this notation, we can more simply present the three main models which will be done in the analysis:

$$Pov_{it} = \beta_1 GG_{i,t-1} + \boldsymbol{\beta} \cdot \boldsymbol{controls_{it-1}} + a_i + u_{it} \tag{1}$$

$$Pov_{it} = \beta_1 GD_{i,t-1} + \beta_2 GDPgrowth_{i,t-1} + \boldsymbol{\beta} \cdot \boldsymbol{controls_{it-1}} + a_i + u_{it} \tag{2}$$

$$\begin{aligned} Pov_{it} = \beta_1 GDPgrowth_{i,t-1} + \beta_2 co2prod_{i,t-1} + \beta_3 pat_{i,t-1} + \beta_4 pollu_{i,t-1} + \beta_5 tempc_{i,t-1} + \\ \beta_6 enerprod_{i,t-1} + \beta_7 renewaener_{i,t-1} + \beta_8 matprod_{i,t-1} + \boldsymbol{\beta} \cdot \boldsymbol{controls_{it-1}} + a_i + u_{it} \end{aligned} \tag{3}$$

The specification of the different variables can be found in table 3. All explanatory and control variables are lagged, as the effect of green growth on poverty is expected to take time (ie. be long-term rather than short-term). Furthermore lags are also applied as a way to overcome fears of reverse causality. By constructing it this way, the time sequence is clear as there is no way that poverty in a following period can impact green growth in the previous period.

Finally, table 4 includes basic descriptive statistics on all the variables, to give a better outset for interpreting the following regression results. A comment to the GDP growth statistics is, that the very high maximum and very low minimum value are since the growth is calculated over 5 years. Likewise, the very high maximum poverty rate is because the poverty threshold applied on countries is based on their income status today. Thus the threshold for extreme poverty in China is based on the UMIC threshold, due to which they get extremely high poverty rates in 1990 when they were a LIC.

Table 3: Complete variable list for empirical analysis

| Type of variable | Variable | Measure | Measured as/in |
|---|---|---|---|
| Outcome variable | Extreme poverty | Population living under IPL (LIC: 1.9; $LMIC$ :3.2; UMIC: $5.5), % of entire population | Mean in period |
| Predictor variable(s): Green Growth | Green patents | Green patents per capita | Mean in period* |
| | Pollution levels | Mean population exposure to PM2.5 (microgram per m3) | Mean in period* |
| | CO2 productivity | Production-based CO2 productivity, GDP per unit of energy-related CO2 emissions | Mean in period* |
| | Energy Productivity | Energy productivity, GDP per unit of TPES | Mean in period* |
| | Non-energy material productivity | Non-energy material productivity, GDP per unit of DMC | Mean in period* |
| | Renewable Energy supply | Renewable energy supply, % total energy supply | Mean in period* |
| | Temperature changes | Annual surface temperature, change since 1951-1980 | Mean in period* |
| | GDP growth | Real GDP growth in percentage from initial to final year | Growth over 5-year period |
| Control variables | Educational attainment | Gross intake, primary school, | Mean in period |
| | Inequality levels | Gini coefficient | Mean in period |
| | Government consumption level | Government consumption expenditure, % of total GDP | Mean in period |
| | Urbanization | Rural population, % of total population | Mean in period |
| | Population size | Total population | Mean in period, logarithm |
| | GDP | Real GDP per capita in 2015 US dollar | Mean in period |

Note: *As noted in the data section, the reported values for the first four periods is for the initial year.

Table 4: Basic descriptive statistics of all variables

| Variable | Mean | Max | Min | Sd | N |
|---|---|---|---|---|---|
| Poverty | 42.83 | 97.30 | 0.16 | 24.46 | 302 |
| Green Growth | 0.08 | 3.99 | -3.66 | 1.16 | 345 |
| Green Development | 0.02 | 1.55 | -0.95 | 0.42 | 345 |
| Green Patents | 0.14 | 1.94 | 0.00 | 0.29 | 366 |
| Pollution | 32.87 | 86.25 | 11.62 | 16.49 | 366 |
| Temperature changes | 0.85 | 2.21 | -0.49 | 0.48 | 354 |
| CO2 productivity | 6.44 | 58.73 | 0.60 | 5.39 | 360 |
| Energy productivity | 8279.31 | 21978.82 | 1097.15 | 3833.77 | 360 |
| Renewable energy | 36.40 | 177.15 | 0.38 | 33.16 | 361 |
| Non-energy productivity | 1.18 | 3.61 | 0.22 | 0.63 | 350 |
| GDP growth | 0.12 | 1.02 | -0.69 | 0.19 | 365 |
| Gini Coefficient | 42.26 | 64.70 | 24.54 | 8.97 | 301 |
| Government Consumption | 13.74 | 36.87 | 1.15 | 4.73 | 352 |
| Urbanization | 48.35 | 86.88 | 8.25 | 18.55 | 366 |
| Population (Millions) | 77.20 | 1,385.35 | 1.36 | 216.26 | 366 |
| Educational Attainment | 105.27 | 165.59 | 26.02 | 17.68 | 333 |
| GDP | 7580.03 | 27144.82 | 479.78 | 5349.79 | 365 |

# 5 Analysis

## 5.1 Descriptive statistics

First, the analysis looks at the descriptive statistics. Table 5 includes means of all the outcome and predictor variables for each individual country, the three income levels, and all countries. Notable here is the expected difference between the income levels. The UMICs on average have the least extreme poverty, the greenest growth, and the highest green development score. The LMICs has a slightly higher (although only with 1 percentage point) average GDP growth than the UMICs. Interestingly this indicates that the high green growth results for the UMICs is due to their higher green development and not the economic growth itself (which is also only 2 percentage points higher than for the LICs). If this is the case, this means that the UMICs have not on average been performing better economically than the other country groups, however, they have to a much larger extent improved on their environmental impact. In fact, only the UMICs are averagely positive on the green development score. Due to the use of standardization this means they are the only income level group that generally are above the average green development over the last 30 years, whereas the LMICs and LICs generally perform under the average green development.

The numbers in table 5 also proves just how large the difference between countries is within the income level groups. This is true for all included variables in the table, an example among the UMICs is how the average GDP growth varies from -8% in Venezuela to 51% in China. It must be stressed that the regression analysis will explore the within country changes, because even if total growth rates differ, they might be equal in their way of alleviating poverty within the countries.

A second note to table 5, is how the green growth is measured. Since it was chosen to compute green growth by adding the green development indicator and the GDP growth, it can as an example be observed that China, although scoring among the lowest on the green indicator (-0.69), still has a positive and decent green growth measure (0.33) simply due to the country's extensive GDP growth (0.51). This highlights that the green indicator can be observed merely as a discount factor of the GDP growth measure when computed this way.

Before the regression analysis, some simple correlations deserve exploration. First it is interesting to look at the correlations between the green development and the GDP growth rate, which as seen in table 5 can vary hugely between countries within income levels. It serves to provide a basic understanding of whether green development and GDP growth seems to work in a trade-off or not based on all data used for the analysis. In figure 1 the overall relationship seems to be that more GDP growth is correlated with a lower green development score, i.e. for the countries in this analysis between 1990 and 2019 there is a slightly downward sloping trend between GDP growth and green development scores. However, country differences should be considered, as these result might show that the countries producing high economic growth are also performing comparatively worse in terms of the green development score than their counterparts. This is different from whether increasing GDP growth within a country correlates with decreasing green development within the same country, which is why the regression analyses are needed.

The downward-sloping trend between GDP growth and green development seems to be largely carried by the UMICs, whereas the correlation seems to be only slightly negative for the LMICs and even positive for the LICs. The very low number of LICs included in the analysis makes it difficult to generalize to other than only these specific five LICs. The upward sloping trend between GDP growth and green development for the LICs probably reveal more about the between country differences than within country changes. Interestingly observed in table 5, the two countries performing best in terms of economic growth (Ethiopia and Mozambique) also have the highest average green development scores. This supports the theory of the use of green growth in lower income countries, since there does not seem

Table 5: List of countries and means for outcome and predictor variable(s)

| Country / group | Poverty | Green Growth | Green development | GDP growth | Country / group | Poverty | Green Growth | Green development | GDP growth |
|---|---|---|---|---|---|---|---|---|---|
| All | 42.83 | 0.08 | 0.02 | 0.12 | LMICs | 45.72 | -0.06 | -0.02 | 0.13 |
| UMICs | 39.14 | 0.25 | 0.07 | 0.12 | Bangladesh | 68.28 | 0.87 | 0.20 | 0.21 |
| Argentina | 20.78 | 0.59 | 0.42 | 0.06 | Benin | 77.17 | 0.43 | 0.33 | 0.07 |
| Armenia | 59.53 | 0.47 | -0.33 | 0.24 | Bolivia | 26.33 | -0.39 | -0.12 | 0.11 |
| Azerbaijan | 31.10 | 0.83 | -0.30 | 0.25 | Cameroon | 59.15 | -0.50 | 0.03 | 0.03 |
| Belarus | 26.26 | -0.51 | -0.55 | 0.18 | Cote d'Ivoire | 56.68 | 0.20 | 0.32 | 0.03 |
| Botswana | 63.73 | -0.26 | -0.07 | 0.12 | Egypt | 31.41 | -0.42 | -0.14 | 0.12 |
| Brazil | 35.91 | 0.32 | 0.34 | 0.05 | El Salvador | 22.66 | 0.79 | 0.44 | 0.09 |
| Bulgaria | 11.53 | -0.11 | -0.24 | 0.11 | Ghana | 50.50 | 0.37 | 0.12 | 0.15 |
| China | 67.12 | 0.33 | -0.69 | 0.51 | Honduras | 40.10 | -0.13 | 0.11 | 0.06 |
| Colombia | 44.23 | 1.04 | 0.52 | 0.10 | India | 72.70 | -0.41 | -0.45 | 0.26 |
| Costa Rica | 22.88 | 1.92 | 0.83 | 0.13 | Kyrgyzstan | 34.81 | -0.61 | -0.32 | 0.05 |
| Dom. Rep. | 31.38 | 1.37 | 0.44 | 0.20 | Lao PDR | 68.14 | 1.87 | 0.45 | 0.26 |
| Ecuador | 46.37 | 0.12 | 0.23 | 0.06 | Moldova | 24.54 | -0.54 | -0.34 | 0.18 |
| Georgia | 57.20 | 1.48 | 0.12 | 0.19 | Mongolia | 20.67 | -1.49 | -0.73 | 0.18 |
| Guatemala | 47.00 | 0.66 | 0.43 | 0.07 | Morocco | 19.24 | -0.60 | -0.21 | 0.12 |
| Indonesia | 82.54 | 0.78 | 0.24 | 0.18 | Nicaragua | 35.96 | 0.13 | 0.18 | 0.08 |
| Iran | 23.88 | -1.48 | -0.48 | 0.07 | Nigeria | 78.92 | -0.60 | -0.15 | 0.09 |
| Jamaica | 41.68 | -0.75 | -0.07 | 0.02 | Pakistan | 59.42 | -0.67 | -0.16 | 0.08 |
| Jordan | 33.22 | -0.64 | -0.08 | 0.05 | Philippines | 33.04 | 0.71 | 0.30 | 0.14 |
| Kazakhstan | 30.06 | -0.70 | -0.58 | 0.16 | Senegal | 74.18 | -1.03 | -0.28 | 0.07 |
| Malaysia | 15.43 | 0.19 | -0.03 | 0.19 | Sri Lanka | 29.03 | 2.55 | 0.87 | 0.23 |
| Mexico | 39.11 | 0.22 | 0.28 | 0.05 | Tanzania | 85.56 | 0.60 | 0.29 | 0.12 |
| Namibia | 64.27 | -0.09 | 0.05 | 0.09 | Tunisia | 18.75 | -0.68 | -0.26 | 0.12 |
| Paraguay | 27.94 | 2.41 | 1.16 | 0.07 | Ukraine | 6.37 | -1.26 | -0.49 | 0.01 |
| Peru | 39.97 | 0.38 | 0.16 | 0.13 | Uzbekistan | 75.70 | -1.41 | -0.83 | 0.15 |
| Russia | 18.64 | -0.68 | -0.34 | 0.07 | Vietnam | 47.33 | 0.88 | 0.00 | 0.30 |
| South Africa | 65.44 | -1.25 | -0.30 | 0.04 | Zambia | 75.31 | -0.12 | 0.10 | 0.07 |
| Thailand | 31.37 | 0.19 | -0.02 | 0.18 | LICs | 50.91 | -0.14 | -0.10 | 0.10 |
| Turkey | 22.28 | 0.97 | 0.35 | 0.15 | Ethiopia | 43.71 | 0.94 | 0.08 | 0.21 |
| Venezuela | 43.40 | -0.56 | 0.26 | -0.08 | Mozambique | 73.85 | 0.34 | 0.04 | 0.18 |
| | | | | | Niger | 67.30 | -1.04 | -0.29 | 0.02 |
| | | | | | Tajikistan | 20.39 | 0.09 | -0.14 | 0.07 |
| | | | | | Togo | 54.20 | -1.15 | -0.25 | 0.03 |

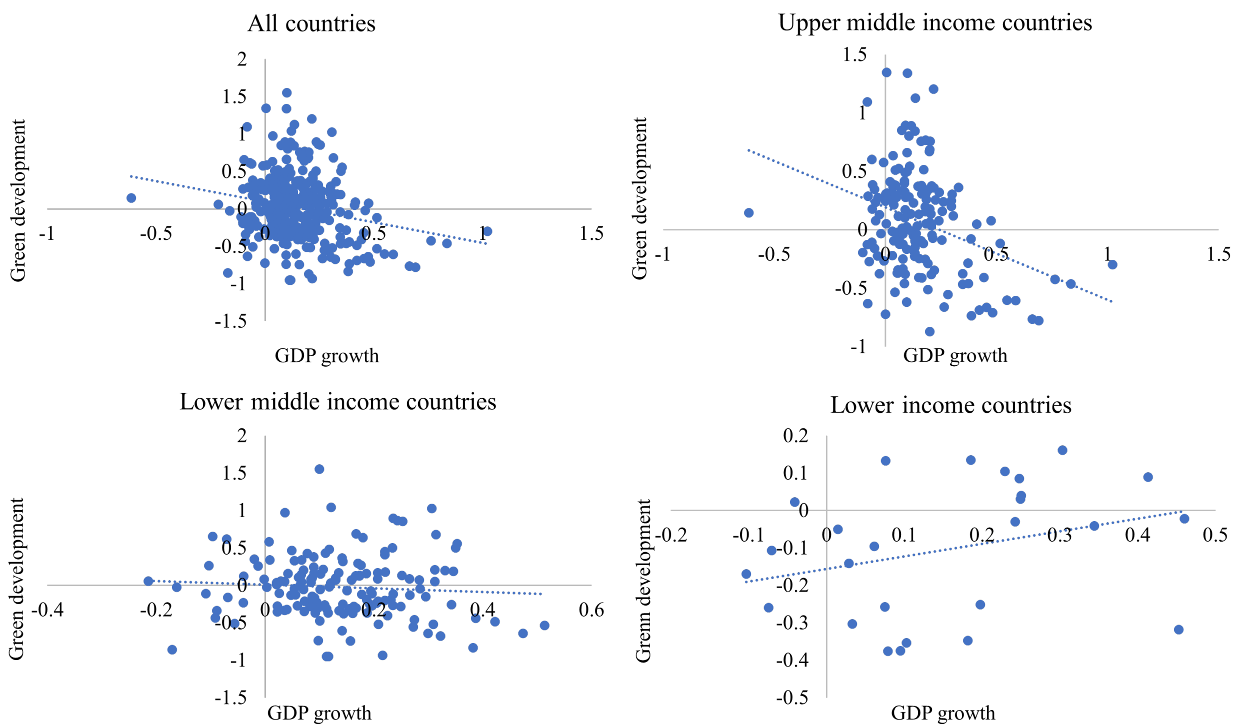


Figure 1: GDP vs Green correlations

to be a trade-off between economic growth and green development in the LICs on average. Instead, it seems that the LICs either grow and improve environmental measures, or they do neither.

When looking at correlations between green growth and poverty, the scatter plots in figure 2 indicates a rather weak correlation as the points seems all over the place. Overall, there is a slightly negative relation suggesting that higher green growth is correlated with very slightly lower poverty rates. The slope seems too horizontal to provide any support for the expectations of whether green growth and poverty works in a trade-off.

The LMICs is the group mostly contradicting our expectations showing a positive trend such that higher green growth correlates with higher poverty levels as well. However, this relationship may be sensitive to the specific countries explored here. Generally, it is interesting that there seems to be no obvious relation from the scatter plots. Thus figure 2 does not provide much insight to the overall aim rather than showcasing the differences between the income level groups. However, this is why regression analysis are insightful, as they can allow for exploration of within country changes that controls for time-invariant factors and

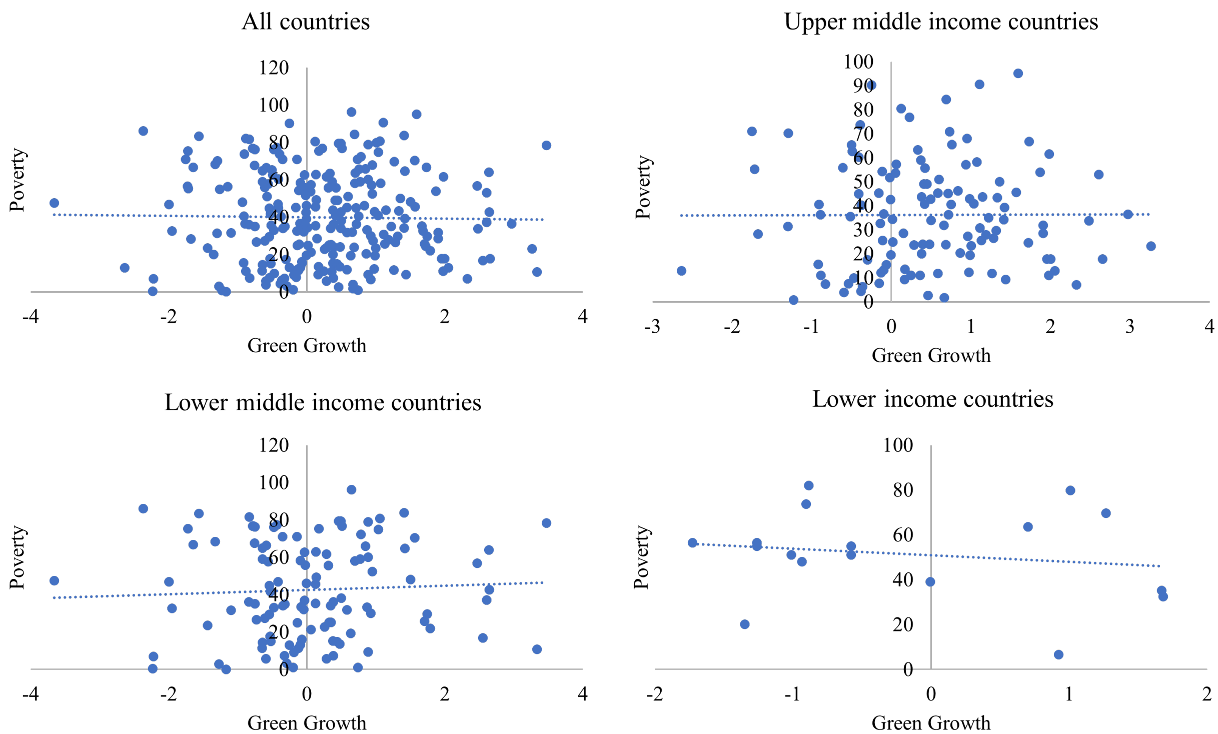


Figure 2: Poverty vs Green Growth correlations

other confounding factors that might cause the very blurry relations in figure 2.

## 5.2 Fixed Effect Analysis

The fixed effects regression analysis is calculated for all countries (UMICs, LMICs, and LICs) and separately for UMICs and LMICs. Due to the low number of observations, regression analyses could not be performed for lower income countries. Control variables are included for all models, but not included in the regression output tables. This is because their coefficients are essentially not of any interest and probably biased, as the models are designed for the predictor variables to be unbiased (Hünermund & Louw, 2020).

### 5.2.1 Green growth as predictor variable

In table 6, where green growth is applied as the predictor variable, all six models indicate a negative impact of lagged green growth on extreme poverty levels, i.e., improving green growth on average decreases poverty in the following period. However, for the main models (1, 2 and 3) this relation is only statistically significant when including all countries and

Table 6: Fixed effect regression with green growth as one predictor variable

| VARIABLES | (1)<br>ALL | (2)<br>UMICs | (3)<br>LMICs | (4)<br>ALL | (5)<br>UMICs | (6)<br>LMICs |
|---|---|---|---|---|---|---|
| Green Growth = L, | -3.213*** | -4.590*** | -2.001 | -1.423 | -2.878** | -0.585 |
| | (0.992) | (1.190) | (1.612) | (0.966) | (1.083) | (1.514) |
| Observations | 197 | 104 | 84 | 197 | 104 | 84 |
| Number of countries | 61 | 29 | 27 | 61 | 29 | 27 |
| Adjusted R-squared | 0.741 | 0.765 | 0.729 | 0.828 | 0.856 | 0.800 |
| Country fixed effect | YES | YES | YES | YES | YES | YES |
| Period fixed effect | NO | NO | NO | YES | YES | YES |
| Controls lagged | YES | YES | YES | YES | YES | YES |

Note: Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

when looking separately on the 29 UMICs, but not when doing the regression separately for the LMICs. Furthermore, the coefficient for the LMICs is less than half the size of the one for the UMICs - so on average if an UMIC increases its green growth by 1 point, then its poverty will decrease by -4.59 percentage points, whereas it would averagely only decrease by -2.001 percentage points in a LMIC. This is interesting as it points towards the relationship being much stronger for the UMICs than the LMICs, which corresponds to the theoretical expectations.

The models controlling for period fixed effect supports the relationship being stronger for UMICs than LMICs. The period fixed effect also diminishes the size of the coefficient from green growth on poverty noticeably for all models. These control models thus supports the tendencies seen both the first three models and in the descriptive graphs in figure 2. This is that the support for hypothesis 1 (green growth having a negative correlation with extreme poverty levels) is mainly found among UMICs. Hence, the hypothesis 2 (the correlations are stronger for UMICs than LMICs) are supported.

### 5.2.2 Green development and GDP growth as predictor variables

Due to how the green growth indicator is constructed it is difficult to know whether the results in table 6 is driven by only economic growth or green development. Therefore, the regressions are performed with economic growth and the green development as separate predictor variables in table 7. Not surprisingly the results indicate that economic growth is the main driver for the negative relationship both in terms of statistical and practical significance, in that it is both more statistically significant and greater in coefficient size. However, it is quite interesting that green development also has a negative relation to poverty levels for all countries and even statistically significant for the UMICs (although only at a 0.1 significance level). In addition, it is interesting that the green development coefficient for the LMICs is positive. Furthermore, neither GDP growth nor green development is showing statistical significance at any level for the LMICs. This makes it difficult to conclude any general pattern for this income level group and might indicate that LMICs are experiencing different relations between green growth and poverty resulting in inconclusive results.

An aim of the thesis is to explore the relevance of green growth for lower income countries, and these inconclusive results for LMICs are not too comforting as there seems to be better ground for arguing that green growth results in poverty alleviation in UMICs than in LMICs. With that said, one must also remember that the classification of the countries is from 2019, and several of the countries will have moved from significantly lower income levels in 1990, which suggests that some countries in the UMICs may come from lower income statuses. Therefore, these results shows that the countries remaining in LMIC status have inconclusive results.

Furthermore, we saw above that in general green growth was lower in LMICs, and therefore we might find a relationship where the predictor variable itself does not have sufficiently variation to get conclusive regression results. In that sense, it could be argued that the UMICs are the ones that have experienced high green growth rates, and therefore it makes sense they are driving the overall results. In other words, the results might indicate, that LMICs have not experienced sufficiently green growth to explore its effect on poverty eradication.

When controlling for the period fixed effect in the last three models in table 7, green development loses statistical significance for all income groups. The relation is only remaining statistically significant for GDP growth on poverty in model (4) and (5). Meanwhile, looking at the coefficients, the sign of green development is still negative for the fourth and fifth model. Again, we see LMICs having a positive coefficient which supports the patterns seen so far, although the support for hypothesis 1 diminishes slightly in these models. However, the expectation was not that the green development should correlate with poverty. These models are therefore only to dig into what might drive the relations found in table 6.

### 5.2.3 Green growth indicators as individual predictor variables

Lastly, in order to explore the effects of the different green indicators, the regressions have been carried out with all the different indicators as separate predictor variables. These

Table 7: Fixed effect regression with green development and GDP growth as predictor variables

| VARIABLES | (1) ALL | (2) UMICs | (3) LMICs | (4) ALL | (5) UMICs | (6) LMICs |
|---|---|---|---|---|---|---|
| Green Development = L, | -4.042 | -9.315* | 2.546 | -0.335 | -3.022 | 2.743 |
| | (4.001) | (4.951) | (8.028) | (4.008) | (5.770) | (7.070) |
| GDP Growth = L, | -19.000*** | -25.124*** | -15.683 | -9.172* | -16.796** | -6.152 |
| | (6.205) | (7.217) | (10.847) | (5.443) | (6.260) | (8.449) |
| Observations | 197 | 104 | 84 | 197 | 104 | 84 |
| Number of countries | 61 | 29 | 27 | 61 | 29 | 27 |
| Adjusted R-squared | 0.741 | 0.763 | 0.731 | 0.828 | 0.855 | 0.799 |
| Country fixed effect | YES | YES | YES | YES | YES | YES |
| Period fixed effect | NO | NO | NO | YES | YES | YES |
| Controls lagged | YES | YES | YES | YES | YES | YES |

Note: Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

results are seen in table 8. It must be stressed that it is mainly included to explore some of the underlying forces, but we do not know whether the individual indicators will have an individual effect directly on poverty alleviation. The fact that temperatures are increasing or that a country produces one green patent can hardly be justified to single-handedly alleviate poverty. However, we would as argued expect the overall green growth to reduce poverty. Most likely, countries are not improving on all indicators at the same time, but might focus on certain aspects, which would blur the results.

With that caution in mind, the results in table 8 first and foremost indicate the strong negative relation between economic growth and poverty alleviation for all countries. As for the green indicators, the picture is not quite clear. Most consistent is the positive coefficient indicating a positive relation between non-energy material productivity and poverty levels and the negative coefficient of energy productivity on poverty levels. The variable green patents should be commented on, as it is interestingly a green growth dimension which LICs are argued to be incapable of applying. Here, the UMICs seems to drive a statistical negative and practical negative relation to poverty directly opposite to the LMICs. So, whereas, one more green patent per capita on average is followed by a poverty alleviation of almost 4 percentage points, it is related to almost the same percentage point increase in poverty levels in LMICs.

The models with the period fixed effect shows some consistency and some differences from the main models. It goes to emphasize just how difficult it is to conclude anything

Table 8: Fixed effect regression with green indicators and GDP growth as predictor variables

| VARIABLES | (1) ALL | (2) UMICs | (3) LMICs | (4) ALL | (5) UMICs | (6) LMICs |
|---|---|---|---|---|---|---|
| Green Patents = L, | -3.613* | -3.821* | 3.456 | -2.440 | -2.385 | 8.147 |
| | (2.125) | (2.156) | (5.976) | (2.270) | (2.358) | (6.303) |
| Pollution = L, | 0.198 | -0.112 | 0.447** | -0.040 | -0.449** | -0.123 |
| | (0.196) | (0.246) | (0.199) | (0.163) | (0.209) | (0.215) |
| Temperature changes = L, | 0.500 | 3.603 | 0.458 | -0.456 | 2.337 | -0.110 |
| | (2.089) | (2.521) | (3.338) | (2.439) | (3.092) | (4.096) |
| CO2 producivity = L, | -0.087 | -0.361 | 0.342 | -0.723 | 0.435 | -1.185* |
| | (0.713) | (1.133) | (0.676) | (0.495) | (0.806) | (0.650) |
| Energy producivity = L, | -0.001* | -0.002** | -0.000 | -0.000 | -0.001* | -0.000 |
| | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) |
| Renewable energy = L, | 0.076 | 0.112 | 0.140 | 0.211* | 0.264** | 0.349 |
| | (0.180) | (0.174) | (0.245) | (0.123) | (0.127) | (0.225) |
| Non-energy material productivity = L, | 8.107** | 9.555** | 18.275* | 5.155 | 3.763 | 24.334** |
| | (3.272) | (3.827) | (10.303) | (3.226) | (3.789) | (10.084) |
| GDP Growth = L, | -19.913*** | -25.566*** | -27.499** | -9.085 | -17.697*** | -13.151 |
| | (6.056) | (7.087) | (10.672) | (5.634) | (6.028) | (10.851) |
| Observations | 197 | 104 | 84 | 197 | 104 | 84 |
| Number of coutries | 61 | 29 | 27 | 61 | 29 | 27 |
| Adjusted R-squared | 0.758 | 0.797 | 0.751 | 0.837 | 0.874 | 0.834 |
| Country fixed effect | YES | YES | YES | YES | YES | YES |
| Period fixed effect | NO | NO | NO | YES | YES | YES |
| Controls lagged | YES | YES | YES | YES | YES | YES |

Note: Robust standard errors in parentheses *** $p<0.01$, ** $p<0.05$, * $p<0.1$

informative from using the green development indicators individually. GDP growth seems to keep its strong relation on poverty, although the LMICs seem to drive the fourth model to loose its statistical significance. CO2 productivity actually turns interestingly into a high coefficient of -1,185 for LMICs and even statistical significant at 0.1 level. Energy productivity remains negative, and the very small coefficient of it must be seen in light of the very high values on this variables, which was also evident in table 4.

To sum up, there seems to be evidence that increasing green growth within a country on average is related to lower extreme poverty levels in the following period. This result on average seems stronger for the UMICs than for the LMICs, and for the latter group there is no statistically significant relationship. Many of these relations seem to be driven by the "normal" economic growth which has a practical significantly larger negative and more statistically significant relationship than the green development indicator, which can be seen from the separate analyses.

To a large extent this supports both of the theoretical expectations, that green growth is related to decreasing poverty levels but also that emerging markets might be in a better position to make use of green growth and thereby to alleviate poverty through green growth. It seems that the relation between green growth and poverty is stronger for UMICs than LMICs in all the models. It must be emphasized that the analyses performed here do not show whether it is the green growth itself that works to alleviate poverty, or whether government initiatives to alleviate poverty have been launched alongside green growth initiatives and thereby serves to give these a spurious relation over time. The analyses are correlations and not causal, so they merely indicate that it is possible to alleviate poverty and have green growth at the same time, thus they do not necessarily work in a trade-off.

# 6 Conclusion

## 6.1 Interpretation and implications of results

The aim of this thesis has been to explore the empirical relation between green growth and poverty among the 61 lower- and middle-income countries. The literature indicated a gap in namely quantitative explorations of the relation, whereas focus has been put on the theoretical arguments for green growth being compatible with poverty alleviation. The theoretical arguments were pro inclusive green growth due to green labor-intensive industries which can gives the poor people employment, and against inclusive green growth as green growth measures are often very costly. However, the outset of this thesis, as seen in the introduction, was that green growth especially though poverty alleviating measures should be able to be inclusive and thus reduce poverty. This demands strong developmental states and market capacity, due to which emerging markets and UMICs - countries which often have more technologically advanced industries and more developed human capital than poorer countries - are argued to have better possibilities for producing inclusive green growth than LMICs and LICs.

The analyses presented here suggest that there is a negative relation between green growth and extreme poverty levels in the long-term. This indicates that on average green growth is not in a trade-off with poverty alleviation. These results are directly contributing to the scholarly debate on whether strategies related to green growth are applicable in the developing world where poverty alleviation is a top priority, and where large investments in green technology might be difficult to carry out and perhaps downgraded.

A comparison of lower- and middle-income countries show that there is a difference in the empirical results, as they seem to indicate that the negative relation between green growth and poverty is strongest for UMICs than LMICs. This might weaken the argument stated above for green growth being relevant in the developing world, at least for the poorest part of the developing world. This is as there is no statistical significance in the findings of correlations between green growth and extreme poverty levels when only exploring LMICs. For the green development indicator, the sign of the coefficient even went positive, indicating that green development increases are correlated with higher poverty levels. These correlations over time are nuanced by the descriptive findings, where the five LICs do not seem to support the idea of a trade-off between green growth and poverty.

On average, the lack of relation between green growth and poverty for LMICs may be due to this group of countries generally not reporting any green growth. Hence it is interesting to explore whether the reason is the structures of green growth making them unable to apply green growth alongside poverty eradicating measures or whether it was a deliberate choice not to apply these strategies for certain reasons. The first might point towards less relevance of green growth strategies but the latter not. Future research could benefit from exploring why green growth is not occurring among LMICs and LICs. The answer to this might be that this thesis explores developments since 1990, while green growth did not emerge as a distinct strategy until 2005-2010. As sustainable development has been on the agenda even before 1990, it is generally defended to believe trends dating back to 1990 can give insightful knowledge on the relations between green growth and poverty.

Another interesting finding is the difference between the impact of green development and economic growth. It is interesting that not only GDP growth but also green development in the main models has a negative coefficient. This indicates that green development averagely also correlates with poverty eradication. With the construction of green growth as a composite indicator, it is an important result that the relationship is not only carried by GDP growth, but that green development also impacts.

An important contribution of this thesis is the method to quantitatively examine the impacts of green growth. Earlier studies have worked with for instance principal component analyses to obtain a component indicator on green growth (Huang & Quibria, 2013). This thesis contributes to the literature with a quantitative method of measuring the relation in a wide covering cross-country study, as measuring green growth through this composite indicator has not been done before. The results supports the idea of exploring green development as a composite concept rather than as individual components in the final regression table. Further research could benefit from exploring how to measure green growth best as a composite concept fitted to different contexts.

These results also contribute to the literature by empirically exploring the cross-country relations between the environmental, economic and social dimensions of green growth. Although single- country studies can help explore the specific relations within a country, it is also important to understand the average relations. When taking into account the vague credence the concept has had in the developing world, empirical assessments as these are necessary in the debate in order to quantify based on knowledge exactly why developing countries should care about this concept. This is a huge complementary to all the impressive work that has been carried out to point out policy strategies of how to implement it. These results indicate that green growth and poverty alleviation is not a trade-off, and the empirical evidence does seem to indicate that one could aim for both at the same time.

By making cross-country studies indications of tendencies, such as the differences between LMICs and UMICs can be found. These results call for more qualitative as well as quantitative studies on the relations between green growth and poverty dependent on income level. An outset could be to explore how much human capital and technological capability in lower income countries account for in this process.

This thesis indirectly contributes to the definition debate on green growth by targeting whether the environmental and economic dimensions are related to the social dimension. Both the theoretical and empirical parts point towards a very mixed and complicated relation between the three dimensions, which are not necessarily unidirectional between all countries and income levels. There is no doubt that from the perspective of development studies, and from a social development standpoint, one should aim for a socially inclusive green growth, which is embedded in the idea of sustainable development. With that being said, the fact that the definition of green growth itself does not necessarily entail the social dimension, does not hinder it being socially inclusive.

At the same time, excluding the social dimension does serve to simplify a concept that has been found difficult to grasp and measure empirically. The difficulties to making a trustworthy measure of green growth reflecting the two dimensions, does emphasize complications for including the third dimension into the concept itself. In sum, one should make a distinction between what a concept is defined as (green growth) and the societal most desirable use of this strategy (e.g., inclusive green growth). It would benefit the research field to acknowledge this difference and agree on a definition, such that future analyses can better complement each other by exploring the same concept defined in the same manner.

## 6.2 Limitations and future research

One area is data limitations. Having a strongly balanced panel dataset on countries from 61 LICs, LMICs, and UMICs over 30 years is a useful outset for making econometric analyses. This allows for exploring how changes in green growth indicators correlates with changes in poverty measures over time within countries. The data sources of the World Bank and the OECD has the strong advantage that they are internationally created, and thereby ensures comparability between countries due to same methodology and data handling.

With that said, the data collection procedures actually vary between countries (OECD, 2011; World Bank, 2021a). An example, is the estimations of poverty, which are partially based on household surveys carried out by national statistical officers, central banks or other national agencies. They are designed to match the needs of each particular country, due to which the household survey questionnaires differ across countries. Hence the comparability of the poverty measures both over time and across economies can be questioned (World Bank, 2021a). However, the regression models used in the analyses directly controls for time-invariant differences between countries also in the measure of poverty. Therefore, the biggest issue for this analysis is the over-time comparability. If estimate procedures vary over time, it will cause spurious relations in the main models. The control models, however, diminishes exactly this endogeneity issue by controlling for the period-fixed effects.

Generally, all empirical results are limited to the extent that the assumptions made for the regression match with reality. This is common in quantitative research. One can try to limit the possibility of these issues and be conscious of the assumptions, but one can never be guaranteed that certain simplifications are true. Therefore, more studies are needed in order to test whether these results are replicable. The consistent patterns in the models in this thesis already indicates some repeatability.

Another limitation is the measurement of green growth. A country may perform very well on green measures that have not been measured here and thereby score lower than what is really the case. The difference between their model score and their actual score lies in all the sub-areas the models do not take into account and all the immeasurable things. The model can only depict an extract of the real world. Thus it could be interesting to explore how other dimensions matter for green development. With that said, this thesis includes aspects which have been argued in the literature as most important for the concept of green growth (Huang & Quibria, 2013; OECD, 2017). Hence the results can probably be translated into general findings of green growth's correlations with extreme poverty levels.

Although the study covers a high number of 61 countries among UMICs, LMICs, and LICs, it is questionable whether results can be further generalized to all lower- and middle-income countries in the world, due to possible selection bias through data availability. Especially regarding lower income countries, research could benefit from exploring these countries in more detail, due to the positive descriptive findings from both Ethiopia and Mozambique which perform well both on the green indicator and growth. The low number of LICs included in this thesis imply that we should be careful to make too broad generalizations concerning countries which are categorized in this income group.

Making a straightforward theoretic expectation depends on the exact policy measure used to apply green growth, which proved difficult in this study. To explore this, an interesting study could be to combine the findings with the environmental policy stringency index developed by the OECD, to better understand which direct policy instruments are related to poverty alleviation and economic growth.

Finally, both the literature field, politicians and society could benefit from more mixed methods research. This thesis has relied on other qualitative findings as its outset to understand the expectations. However, it would be useful to carry out a study which is designed to use mixed methods. This allows for a more complementary structure of both the qualitative and quantitative parts. This could enhance quantitative findings, by for instance trying to understand these in depth through qualitative follow up research.

## 6.3 Concluding remarks

In summary, the research question was how green growth was correlated with extreme poverty levels and how this relation differed from upper to lower-middle income countries. To the first part of the question, the answer seems to be that increasing green growth (with respect to the eight areas it is defined through) on average is correlated with long-term decreasing extreme poverty levels within the 61 lower- and middle income countries explored over the last 30 year. To the latter part of the question the answer seems to be, that this negative relationship between green growth and extreme poverty is averagely driven by upper-middle income countries, whereas results for lower-income countries are generally weak and questionable. Therefore it is argues green growth does not necessarily work in a trade-off with poverty alleviation, however, further research must explore findings for lower- and lower-middle-income countries. Thus these results are an interesting outset to hopefully many further studies.

# References

Ahlert, G., Meyer, B., Zieschank, R., Diefenbacher, H., & Nutzinger, H. G. (2013). Synopsis of Approaches to Welfare and of Green Growth Concepts Currently under Discussion. *GWS Discussion Paper*, No. 2013/1, Gesellschaft für Wirtschaftliche Strukturforschung (GWS)

African Development Bank (AfDB), Organisation for Economic Cooperation and Development (OECD), United Nations (UN), & World Bank (WB). (2012). A Toolkit of Policy Options to Support Inclusive Green Growth.

Albagoury, S. (2016). Inclusive Green Growth in Africa: Ethiopia Case Study, *MPRA Paper*, University Library of Munich, Germany

Aye, G., & Edoja, P. (2017). Effect of economic growth on CO2 emission in developing countries: Evidence from a dynamic panel threshold model, *Cogent Economics & Finance*, vol. 5, nr. 1, pp. 1379239-

Banerjee, A. V., & Duflo, E. (2003). Inequality and Growth: What Can the Data Say? *Journal of Economic Growth* (Boston, Mass.), vol. 8, nr.3, pp. 267-299

Barbier, E. B. (2010). Poverty, development, and environment, *Environment and Development Economics*, vol. 15, nr. 6, pp. 635-660

Barbier, E. B. (2016). Is green growth relevant for poor economies? *Resource and Energy Economics*, vol. 45, 2016, pp. 178-191

Barbier, E. B. (2014). Climate change mitigation policies and poverty: Climate change mitigation policies, *Wiley Interdisciplinary Reviews. Climate Change*, vol. 5, nr. 4, pp. 483-491

Bass, S., Steele, P., Toulmin, C., Greenfield, O., Hopkins, C., Chung, I., & Nielsen, T. (2016) Pro-poor, Inclusive Green Growth: Experience and a New Agenda, Global Green Growth Institute (GGGI), availiable online at: https://gggi.org/site/assets/uploads/2017/11/2016-05-Pro-Poor-Inclusive-Green-Growth.pdf [Accesed May 2021]

Banda, T., & Bass, S. (2014) Inclsuive Green Growth in Zambia: Scoping the needs and potential, Country report February 2014, aviliable online at: https://pubs.iied.org/16558iied [Accesed May 2021]

Baumert, N., Kander, A., Jiborn, M., Kulionis, V., & Nielsen, T. (2019). Global outsourcing of carbon emissions 1995-2009: A reassessment, *Environmental Science  Policy*, vol. 92, pp. 228-236.

Barro, R. (2000). Inequality and Growth in a Panel of Countries, *Journal of Economic Growth*, (Boston, Mass.), vol. 5, nr. 1, pp. 5-32.

Bloom, D. E., Canning , D. & Malaney, P. N. (2000). Population Dynamics and Economic Growth in Asia, *Population and Development Review*, vol. 26, pp. 257-290

Bloom, D. E., & Finlay J. E. (2009). Demographic Change and Economic Growth in Asia, *Asian Economic Policy Review*, vol. 4, nr. 1, pp. 45-64

Brandt, U. B., & Svendsen , G. T. (2006). Climate change negotiations and first-mover advantages: the case of the wind turbine industry, *Energy Policy*, vol. 34, nr. 10, pp. 1175-1184

Brundtland Commission (1987). Report of the World Commission on Environment and Development: Our Common Future, New York, United Nations

Casado-Asensio, J., Wang, S., Moilwa, K., & Drutschinin, A. (2014). Green Development Co-operation in Zambia: An Overview, *OECD Green Growth Papers*, 2014-03, OECD Publishing, Paris

Chiu, D. (2017). The East Is Green: Chinas Global Leadership in Renewable Energy, *New Perspectives in Foreign Policy* Issue 13, Summer 2017: 3-12.

Dabrowski M. (2020) Emerging Markets and Their Role in a Global Economy. *In: Klonowski D. (eds) Entrepreneurial Finance in Emerging Markets*, Palgrave Macmillan, pp. 3-17

Deaton, A. (2010). Price Indexes, Ineaulity, and the Measurement of World Poverty, *American Economic Review*, vol. 100, no. 1, pp. 1-34

Dercon, S. (2014). Is Green Growth Good for the Poor?, *World Bank Research Observer*, vol. 29, nr.2, pp. 163-185

Dollar, D., Kleineberg, T., & Kraay, A. (2015). Growth, inequality and social welfare: cross-country evidence, *Economic Policy*, vol. 30, nr. 82, pp. 335-377

Fang, K., Zhou, Y., Wang, S., Ye, R. & Guo, S. (2018). Assessing national renewable energy competitiveness of the G20: A revised Porter's Diamond Model, *Renewable and Sustainable Energy Reviews*, vol. 93, pp. 719-731

Fankhauser, S., Bowen, A., Calel, R., Dechezleprêtre, A., Grover, D., Rydge, J., & Sato, M. (2013). Who will win the green race? In search of environmental competitiveness and innovation, *Global Environmental Change*, vol. 23, pp. 902-913

Farber, D. A. & Hemmersbaugh, P. A. (1993). The shadow of the future: discount rates, later generations, and the environment, *Vanderbilt law review*, vol. 46, nr. 2, pp. 267-

Ferreira, F., & Sanchez-Paramo, C. (2017). A richer array of international poverty lines, *World Bank Lets Talk Development Blog*, Available online at: https://blogs.worldbank.org/developmenttalk/richer-array-international-povertylines? [Accesed 5 May 2021]

Grunewald, N. & Martínez-Zarzoso, I. (2014). Green Growth in Mexico, Brazil and Chile: Policy strategies and future prospects, *Ibero America Institute for Econ. Research (IAI) Discussion Papers*, vol. 229, Ibero-America Institute for Economic Research.

Hickel, J., & Kallis, G. (2020) Is Green Growth Possible?, *New Political Economy*, vol. 25, nr. 4, pp. 469-486

Huang, Y. & Quibria, M.G. (2013). Green Growth: Theory and Evidence, *WIDER Working Paper*, vol. 56, 2013

Huberty, M., Gao, H., Mandell, J., & Zysman, J. (2011) Shaping the Green Growth Economy: A Review of the Public Debate and the Prospects for Green Growth, *Berkeley Roundtable on the International Economy (BRIE)*

Hünermund, P. & Louw, B. (2020). On the Nuisance of Control Variables in Regression Analysis. Working Paper, availiable online at: https://arxiv.org/abs/2005.10314v2 [Accesed May 2021]

Iradian, G. (2005). Inequality, Poverty, and Growth Cross-Country Evidence. International Monetary Fund (IMF) working paper WP/05/28.

Jacobs, M. (2012) Green Growth: Economic Theory and Political Discourse. Grantham Research Institute on Climate Change and the Environment, London School of Economics and Political Science, (CCCEP Working Paper No. 108 ; Grantham Working Paper No. 92)

Jackson, T., & Victor, P. A. (2019) Unraveling the claims for (and against) green growth See all authors and affiliations, *Science*, vol. 366, nr. 6468, pp. 950-951

Jänicke, M. (2012). Green growth: From a growing eco-industry to economic sustainability, *Energy Policy*, vol. 48, pp. 13-21

Jolliffe, D. & Prydz, E. B. (2016). Estimating international poverty lines from comparable national thresholds: a robust approach for estimating relevant thresholds, *The Journal of Economic Inequality*, vol. 14, nr.2, pp. 185-198

Kallis, G. (2011). In defence of degrowth, *Ecological economics*, vol. 70, nr.5, pp. 873-880.

Klein, J., Jochaud, P,. Richter, H.,Bechmann, R. & Hartmann,S (2013). Green Economy in SubSaharan Africa: Lessons from Benin, Ethiopia, Ghana, Namibia and Nigeria. Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

Linster, M., & Yang, C. (2018), Chinas Progress Towards Green Growth: an international perspective, *OECD Green Growth Papers*, no. 2018/05, OECD Publishing, Paris.

Lopez, H., Servén, L. (2009). Too Poor to Grow. Policy Research working paper ; no. WPS 5012. World Bank. https://openknowledge.worldbank.org/handle/10986/4204 License: CC BY 3.0 IGO.

Margulis, S., Narain, U., Chinowsky, P., Cretegny, L., Hughes, G., Kirshen, P., Kuriakose, A., de Lange, G., Nelson, GW., Neumann, J., Nicholls, R. J., Pandey, K., Price, J., Schlosser, A., Schneider, R., Sedjo, R., Strzepek, K. M., Sumaila, R., Ward, P. J., & Wheeler, D. (2009). The Costs to Developing Countries of Adapting To Climate Change. New Methods and Estimates. The Global Report On the Economics of Adaptation to Climate Change Study. Consultation Draft. The World Bank. availiable online at: http://siteresources.worldbank.org/INTCC/Resources/EACCReport0928Final.pdf [Accesed May 2021]

Moseley, W. G. (2001). African evidence on the relation of poverty, time preference and the environment, *Ecological Economics*, vol. 38, nr. 3, pp. 317-326

Moser, G. G., & Ichida, T. (2001). Economic Growth and Poverty Reduction in Sub-Saharan Africa, IMF Working Papers 2001/112, International Monetary Fund

Nardo, M., Saisana, M., Saltelli, A., Tarantola, S., Hoffman, A., & Giovannini, E. (2005). Handbook on Constructing Composite Indicators: Methodology and User Guide, *OECD Statistics Working Papers*, no. 2005/03, OECD Publishing, Paris

Narlock, U., Kozluk, T., & Lloyd, A., (2016) Measuring Inclusive Green Growth at the Country Level: Taking Stock of Measurement Approaches and Indicators. GGKP Research Committee on Measurement Indicators. Working Paper 02 2016

Organization for Economic Cooperation and Development (OECD), (2006). Cost-Benefit Analysis and the Environment: Recent Developments. Paris: Organization for Economic Cooperation Development.

Organization for Economic Cooperation and Development (OECD), (2011). Towards Green Growth: Monitoring Progress: OECD Indicators, Organization for Economic Cooperation and Development (OECD), (2012). Green Growth and Developing Countries A Summary for Policy Makers

Organization for Economic Cooperation and Development (OECD), (2014). Green Growth Indicators 2014, OECD Green Growth Studies, OECD Publishing

Organization for Economic Cooperation and Development (OECD) (2017), Green Growth Indicators 2017, OECD Publishing, Paris.

Ota, T. (2017). Economic growth, income inequality and environment: assessing the applicability of the Kuznets hypotheses to Asia, *Palgrave Communications*, vol. 3, nr. 1, pp. 1-23.

Peters, G. P., Minx, J. C, Weber, C. L. & O. Edenhofer (2011). Growth in Emission Transfer via International Trade from 1990 to 2008, *Proceedings of National Academy of Science*, vol. 108, no 21, pp. 8903-8908.

Perkins, D. H., Radelet, S., Lindauer, D. L., & Block, S. A. (2013). Economics of development, New York, W.W. Norton Company.

Pritchett, L. (2003), Who Is Not Poor? Proposing a Higher International Standard for Poverty, *CGD Working Paper*, nr. 33

Rische, M., Röhlig, A. M., & Stöver, J. (2014). Green, greener, grey: Disentangling different types of green growth, *HWWI Research Paper*, nr. 160, Hamburgisches WeltWirtschaftsInstitut (HWWI), Hamburg

Sachs, J. D. & Someshwar., S. (2012). Green Growth and Equity in the Context of Climate Change: Some Considerations, *ADBI Working Paper*, nr. 371. Tokyo: Asian Development Bank Institute.

Saisana M. & Tarantola S. (2002), State-of-the-art report on current methodologies and practices for composite indicator development, EUR 20408 EN, European Commission-JRC: Italy

Saisana M., Tarantola, S. & Saltell,i A. (2005). Uncertainty and sensitivity techniques as tools for the analysis and validation of composite indicators, *Journal of the Royal Statistical Society A*, vol. 168, nr.2, pp. 307-323.

Saltelli A. (2007) Composite indicators between analysis and advocacy, *Social Indicators Research*, vol. 81, pp. 65-77

Serajuddin, U., & Hamadeh, N., (2020) New World Bank country classifications by income level: 2020-2021. World Bank Data Blog. Available online: https://blogs.worldbank.org

/opendata/new-world-bank-country-classifications-income-level- 2020-2021 [Accesed 5 May 2021]

Scott, A., McFarland, W., Seth, P. (2013). Research and Evidence on Green Growth. Overseas Development Institute and the UK Department for International Development, London.

Schoneveld, G., & Zoomers, A. (2015). Natural resource privatisation in Sub-Saharan Africa and the challenges for inclusive green growth, *International Development Planning Review*, vol. 37, nr. 1, pp. 95-118

Sharpe A. (2004). Literature Review of Frameworks for Macro-indicators, Centre for the Study of Living Standards, Ottawa, CAN.

Smulders, S., Toman, M., & Withagen, C. (2014). Growth Theory and Green Growth, OxCarre Research Paper.

Stern, N. (2007). The Economics of Climate Change: The Stern Review. Cambridge, UK: Cambridge University Press.

Suckhdev, P., Stone, S., & Nuttail, N. (2010). Green Economy: Developing Country Success Stories. United Nations Environment Programme (UNEP)

Sun, Y., Ding, W., Yang, Z., Yang, G., & Du, J. (2020) Measuring China's regional inclusive green growth, *Science of The Total Environment*, vol. 713

United Nations Department of Economics and Social Affairs (UN-DESA), (2012). A Guidebook to the Green Economy Issue 1: Green Economy, Green Growth, and Low-Carbon Development - history, definitions and a guide to recent publications. Availiable online at: https://sustainabledevelopment.un.org/index.php?page=viewtype=400nr=634menu=35 [Accesed May 2021]

United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP) (2012). Low Carbon Green Growth Roadmap for Asia and the Pacific turning resource constraints and the climate crisis into economic growth opportunities

United National Environmental Programme (UNEP). (2011). Towards a Green Economy: Pathways to Sustainable Development and Poverty Eradication. Nairobi: United Nations Environment Programme.

Wei, Z. & Hao, R. (2010). Demographic structure and economic growth: Evidence from China, *Journal of Comparative Economics*, vol. 38, nr.4, pp. 472-491

Wooldridge, J. M. (2016). Introductory econometrics : a modern approach, 6 ed. Boston: Cengage Learning.

World Bank. (2012). Inclusive Green Growth : The Pathway to Sustainable Development. Washington, DC. © World Bank. Availiable online at: https://openknowledge.worldbank.org/handle/10986/6058 [Accesed May 2021]

World Bank. (2018a). Poverty and Shared Prosperity 2018: Piecing Together the Poverty Puzzle. Washington, DC: World Bank.

World Bank. (2018b). Poverty headcount ratio at $1.90 a day (2011 PPP) (% of population) - Sub-saharan Africa. Available at: https://data.worldbank.org/indicator/SI.POV.DDAY?locations=ZG [Accessed May 2021]

World Bank. (2019a). CO2 emissions (kt) - World. Available online at: https://data.worldbank.org/indicator/EN.ATM.CO2E.KT [Accessed May 2021]

World Bank. (2019b). GDP (constant 2010 US$) - World. Available online at: https://data.worldbank.org/indicator/EN.ATM.CO2E.KT [Accessed May 2021]

World Bank. (2020). Poverty and Shared Prosperity 2020: Reversals of Fortune. Washington, DC: World Bank.

World Bank. (2021a), Methodlogy, PovcalNet, The World Bank. Availiable online at: http://iresearch.worldbank.org/PovcalNet/methodology.aspx [Accessed May 2021]

World Bank. (2021b). World Developent Indicators. Avialiable online at: https://datatopics.worldbank.org/world-development-indicators/ [Accesed May 2021]