

T.C.

ANKARA YILDIRIM BEYAZIT UNIVERSITY

THE INSTITUTE OF SOCIAL SCIENCES

ESSAYS ON ECONOMICS OF SUSTAINABILITY

Ph.D. DISSERTATION

Amber IMTIAZ

DEPARTMENT OF ECONOMICS

ANKARA, 2022

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PLAGIARISM PAGE

I hereby declare that all information in this thesis has been obtained and presented by academic rules and ethical conduct. I also declare that, as required by these rules and conduct, I have fully cited and referenced all material and results that are not original to this work; otherwise I accept all legal responsibility. 23.11.2022.

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ACKNOWLEDGMENTS

First and foremost, I would like to express my sincere gratitude to my supervisor Assoc. Prof. Dr. Fatih Cemil ÖZBUĞDAY for his patience, guidance, encouragement, and immense knowledge. Without his active involvement, it was not possible to complete this thesis.

I would also like to thank the members of the examining committee, Assoc. Prof. Dr. Ibrahim DEMIR, and Assistant Prof. Dr. Erkan GÜRPINAR for their time, invaluable and insightful comments, suggestions and advices.

My sincere thanks also go to my colleague Dr. Ashar Awan who helped me to resolve the data issues.

From the bottom of my heart I would like to thank my mother and my dear siblings for being my rock throughout my life.

My deepest appreciation belongs to my husband who has been walking by my side and supported me in an unconditional way to complete this dissertation. Last but not the least, I would appreciate my children Abeeha and Muhammad Fareed. They have made me stronger, better and more fulfilled.

Amber IMTIAZ

ABSTRACT

Essays on Economics of Sustainability

This thesis consists of three independent studies on sustainability. The first study aimed at exploring the sustainability situation of selected South Asian countries by using indicators of weak and strong sustainability. The study employs descriptive statistics analysis and covers the period between 1990-2014. The findings suggest that South Asian economies such as Bangladesh, Maldives, and Nepal satisfy weak sustainability criterion, while India and Pakistan are the worst-performing countries and fail to satisfy sustainability criterion. The result also indicates that none of the South Asian countriessatisfies the criterion of strong sustainability.

The second study constructs a model to explore the potential relations between income inequality and carbon dioxide emissions of developing countries by dividing the (whole (global)) sample into sub-samples (upper-middle-income and low and lower-middle-income countries. This research uses the system generalized method of moments (GMM) methodology in a dynamic framework to address the issues of unobserved individual country-oriented effects and potential endogeneity. The empirical outcomes confirm the negative correlation between income inequality and carbon dioxide emissions, and the results do not change when the aggregate sample is divided into sub-samples. In all three groups, results indicate the existence of a negative relationship between income inequality and CO2 emissions.

Finally, the third study analyzes the impacts of the determinants of individuals' pro-environmental behavior around the globe. The study employs Logit methodology and covers the period throughout 1981-2018. The study finds education, trust, and institutional quality as important factors affecting the pro-environmental behavior of individuals.

Keywords: Sustainability, Co2 Emission, Income Inequality, Developing Countries, Environmental Concern, Postmaterialism

ÖZET

Sürdürülebilirlik Ekonomisi Üzerine Denemeler

Bu tez, sürdürülebilirlik üzerine üç bağımsız çalışmadan oluşmaktadır. İlk çalışma, zayıf ve güçlü sürdürülebilirlik göstergelerini kullanarak seçilen Güney Asya ülkelerinin sürdürülebilirlik durumunu keşfetmeyi amaçladı. Çalışma, betimsel istatistik analizine dayalıdır ve 1990-2014 dönemini kapsamaktadır. Bulgular, Bangladeş, Maldivler ve Nepal gibi Güney Asya ekonomilerinin zayıf sürdürülebilirlik kriterini karşıladığını, Hindistan ve Pakistan'ın ise en kötü performans gösteren ülkeler olduğunu ve sürdürülebilirlik kriterini karşılayamadığını gösteriyor. Sonuç aynı zamanda Güney Asya ülkelerinin hiçbirinin güçlü sürdürülebilirlik kriterini karşılamadığını da göstermektedir.

İkinci çalışma, (tüm (küresel) örneklemi) alt örneklemlere (üst-orta gelirli ve düşük ve alt-orta gelirli ülkeler) bölerek, gelişmekte olan ülkelerin gelir eşitsizliği ve karbondioksit emisyonları arasındaki potansiyel ilişkileri keşfetmek için bir model oluşturur. Bu araştırma, gözlemlenmeyen bireysel ülke odaklı etkiler ve potansiyel içsellik konularını ele almak için dinamik bir çerçevede sistem genelleştirilmiş momentler yöntemini (GMM) kullanır. Ampirik sonuçlar, gelir eşitsizliği ile karbondioksit emisyonları arasındaki negatif ilişkiyi doğrular ve toplu örneklem alt örneklemlere bölündüğünde sonuçlar değişmemektedir.Her üç grupta da sonuçlar gelir eşitsizliği ile CO2 emisyonları arasında negatif bir ilişkinin varlığına işaret etmektedir.

Son olarak, üçüncü çalışma, dünya çapında bireylerin çevre yanlısı davranışlarının belirleyicilerinin etkilerini analiz ediyor. Çalışma Logit metodolojisini kullanmakta ve 1981-2018 dönemini kapsamaktadır. Çalışma, bireylerin çevre yanlısı davranışlarını etkileyen önemli faktörler olarak eğitim, güven ve kurumsal kaliteyi bulmaktadır.

Kelimeler: Sürdürülebilirlik, Co2 Emisyonu, Gelir Eşitsizliği, Gelişmekte Olan Ülkeler, Çevresel Kaygi, Postmateryalizm

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LIST OF ABBREVIATIONS

WECD	:	World Commission on Environment and Development
SDGs	:	Sustainable Development Goals
WVS	:	World Values Survey
NDU	:	Non-Declining Utility
CES	:	Constant Elasticity of Substitution
WS	:	Weak Sustainability
SS	:	Strong Sustainability
NNP	:	Net National Product
GS	:	Genuine Savings
ISWE	:	Index of Sustainable Economic Welfare
EKC	:	Enviornmental Kuznets Hypothesis
PWSDR	:	Power-Weighted Social Decision Rule
GDP	:	Gross Domestic Product
CO2	:	Carbon Dioxide Emission
PR	:	Political Rights
UMI	:	Upper Middle Income
LMI	:	Lower Middle Income
IPCC	:	Intergovernmental Panel on Climate Change
NDU	:	Non Declining Utility

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1. INTRODUCTION

Sustainability is one of the most acknowledged subjects of recent times. Although it is often considered as a new phenomenon, it has been with mankind through the last two millennia. Its root can be traced back to centuries ago, when in 1798, Malthus predicted th at the ever-growing population would outstrip the food supply. In 1856, Jevon worried about the continuity of Britain's energy consumption given the finite coal supply. However, renewed interest emerged with the publication of the Club of Rome report on The Limits to Growth in 1972 (DH Meadows, Meadows, Randers, & Behrens, 1972), followed by a series of books on sustainability in the early 1980s (Brown, 1981; Coomer, 1981). Although the idea was around, the concept, however, gained broad prominence and acceptance in the policy debate with the publication of the widely known report of the Brundtland Commission, 'Our Common Future' by the World Commission on Environment and Development (WECD 1987). The report voiced that development and environment are inexorably interlinked challenges and demanded balancing economic development with environmental preservation.

The report highlighted the fact that the process of industrialization has brought a revolution in the lives of people in the form of a better standard of living. However, this change came at the cost of unprecedented challenges to the social and ecological stability of our planet. The challenges include rising sea levels, melting glaciers, reduction in crop yield, deforestation, changes in regional climate (Claesson & Nycander, 2013; Oskamp, 2000), increase in crime rates (Rotton & Cohn, 2003), armed conflict and failure of state (Salehyan & Hendrix, 2014), thereby a threat to the existence of human's life (Intergovernmental panel on climate change (IPCC, 2001). As the magnitude of these issues is brought to public attention, the concern for sustainability is on the rise. These concerns have attracted researchers' interest in economics, sociology, and other fields interested in investigating the ways to move on a sustainable path.

Although the concept has garnered popularity and acceptability all over the world, little headway appears to have been made in terms of the operationalization of the concept. The idea still seems unclear and differing interpretations have made it difficult to integrate into a practical guide for policy both at the micro and macro level. Against that backdrop, the present study aspires to look into different aspects of sustainability. Accordingly, this thesis reports three independent essays on the economics of sustainability in the subsequent three chapters. These essays concentrate on the issues in a data-rich environment.

The first study discusses the idea of sustainability from an economics perspective. Economic literature offers a number of competing models to capture sustainability with varying degrees of variability and applicability. The question about which approach is closely related to capturing sustainability is far from consensus and opens for further exploration. The disagreements beg to address several areas: improving the clarity of the idea of sustainability and clarity of indicators used for gauging sustainability to encourage the empirical investigation of sustainability issues. Therefore, the purpose of the first study is to summarize and synthesize the different theories encapsulating the economics of sustainability for understanding current knowledge about sustainability and highlighting the significance of new research. Furthermore, improve the clarity of sustainability indicators to encourage the empirical investigation of sustainability issues and finally give an empirical analysis of South Asian economies' sustainability situation.

The first essay focuses on inter-generational equity, which is the equity and fairness between present and future generations for the long-term decision-making of a society. It ignores any intra-generational issues that deal with equity among current generations.

Realizing the importance of intra-generational equity or, in other words, distributional issues, particularly for developing countries, the second essay investigates the link between income inequality and carbon dioxide emissions. The current period has seen an increase in the social and environmental crisis globally. The social crisis is characterized by an increase in income inequality across the globe. On the one hand, the sharp rise in income inequality across the globe not only undermines

economic growth but also gives rise to a plethora of problems, such as poverty (Hübler, 2017; Persson & Svensson, 1994; Piketty, 2014), harm social order (R. G. Wilkinson & Pickett, 2009), increased health risks (Kaplan, Pamuk, Lynch, Cohen, & Balfour, 1996; Lynch, Smith, Kaplan, & House, 2000; R. Wilkinson & Hughes, 2000) high risk of political instability (Acemoglu, Johnson, & Robinson, 2005; Alesina & Perotti, 1996). On the other hand, the environmental crisis has been manifested in increasing environmental pressures since the 1950s, which has resulted in climatic disturbances and notable widespread changes in the ecosystem (Assessment, Assessment, & Assessment, 2005). Given this premise, understanding the link between income inequality and carbon emissions is of paramount importance to enhance our understanding of these challenges. The global community is acutely aware of these challenges, and their importance is reflected by their inclusion in the Sustainable Development Goals (SDGs). Untangling the inequality-environment nexus has important implications for environmental economists and development practitioners who want to solve the twin issues of reduction in income inequality and improving the environment to ensure a sustainable outlook.

This study, therefore, builds a model to discover the potential linkage between income inequality and carbon dioxide emissions of developing countries by dividing the (whole (global)) sample into sub-samples (upper-middle income and low and lower-middle-income countries.

In this respect, the contribution of the present study is manifold. (i) Unlike previous studies, which ignored the econometric issues, this study uses the system generalized method of moments (GMM) methodology in a dynamic framework to address the issues of unobserved individual country-oriented effects and potential endogeneity. (ii) This study explores the possible political channel that could affect the relationship between inequality and carbon emission along with economic mechanisms, thus presenting a more comprehensive view. (iii) This study provides a global perspective for the developing countries around all continents, along with evidence in a comparative setting for the upper-middle-income and low- and lower-middle-income countries.

Unlike the first two studies, which focus on macro dimensions of sustainability, the third essay looks into the matter from the micro perspective. Given the scientific evidence that the main cause of climate change /GHG emissions is related to human activities (Nordlund & Garvill, 2002), and protecting the environment requires fundamental changes in the behavior of individuals, the third essay tries to explore the determinants of individuals' pro-environmental behavior around the globe.

The study builds on the previous literature with some extensions. In particular, the study aspires to test the competing hypotheses of individuals' pro-environmental behavior. However, the following extensions have been made. First, the current study improves on existing literature by assessing the data from a relatively larger group of countries having diverse levels of economic development, which makes it possible to generalize results to other nations not included in the sample. The study includes 106 countries of the world, out of which 41 developed and 65 countries from developing regions (both upper-middle and lower-middle income countries) have been analyzed. The present study compares a sample of countries by dividing them into developed and developing regions. Second, the study analyzes data from seven waves of World Values Survey (WVS) data. To the best of our knowledge, none of the previous studies have used such a large data set. Most of the previous literature has used data from one point in time; the only exception is the study of Hao (2016) which uses data from four waves of the WVS data set. The present study uses data sets from all seven waves covering 2018 to unpack the factors behind individuals' willingness to contribute to environmental quality improvement. Last but not least, the present study uses a richer set of independent variables as compared to the previous literature.

1.1 Outlines of Thesis

The organization of the thesis is as follows: The following three chapters introduce three independent studies, their literature reviews, empirical results, and discussions. Finally, the last chapter concludes the thesis study.

2. THEORIES OF SUSTAINABILITY: AN ECONOMIC PERSPECTIVE

2.1 Introduction

Sustainability is one of the most acknowledged subjects of recent times. However, concern about sustainability is not a new phenomenon and is as old as dismal science itself. Its root can be traced back to centuries ago, when in 1798, Malthus predicted that the ever-growing population would outstrip the food supply. In 1856, Jevon worried about the continuity of Britain's energy consumption given the finite coal supply. A renewed form of Malthusianism re-emerged in the early 1970s with the publication of 'Limits to Growth' (DH Meadows, et al., 1972). The authors of the report pondered about the continuity of the growth process given the finite capacity of the planet to provide material inputs and its limited ability to assimilate waste. They prophesied that the current pace of expansion in industrial civilization would be unsustainable because of the natural resource limits levied by a finite planet. Therefore, resource scarcity would not only lead to a halt in economic growth but eventual economic contraction might be enforced sometime in the 21st century. The '*Limits to Growth'* provoked a wide range of responses from different spheres of life, including mainstream economists such as (P. Dasgupta & Heal, 1974; R. M. Solow, 1974; Joseph Stiglitz, 1974). Their ideas about the impact of nonrenewable resources on growth still dominate the sustainability debate in economics. However, apart from only a few notable developments, the next decade did not contribute much to the debate. The concept of sustainable development came into the public discourse after it was finally formalized in 1987, with the publication of the widely known report '*Our Common Future'* by the World Commission on Environment and Development (WECD). The report is also known as the Bruntland Commission report (Brundtland, 1987). The report voiced that development and environment are inexorably interlinked challenges and demanded balancing economic development with environmental preservation. The publication highlighted that the growth process adopted for 150 years had resulted in unparalleled challenges to our planet's social and ecological stability. It thereby challenged neoclassical economics and its primary goals and assumptions about the

growth process[1]and revived the concern for the adequacy of environmental resources for the long-term future. One noteworthy feature of WCED's that differentiates it from the previously mentioned publication '*Limits to Growth'*[2]is its focus on the sheer depletion of non-renewable resources and its associated harmful effects on poverty, with a particular focus on the long-term future of developing countries. Moreover, it put the themes of sustainability and sustainable development as popular catchphrases in development discourse.

The commission defines sustainable development[3] as:

"Development that seeks to meet the needs of current generations without compromising the needs or ability of future generations to meet their own needs."

The focus of sustainable development, as defined by the Brundtland Commission, was both on equity between (inter-generational) as well as equity within generations (intra-generational).

The wide acceptance of the slogan 'sustainable development' was demonstrated by the United Nations Earth Summit, taking place in Rio de Janerio in 1992, where world leaders of 108 countries vowed to support the goal (United Nations 1997), thus making it one of the precious political assets in terms of global consensus. Although the concept, since its inauguration, has been around for more than three decades and has garnered popularity and acceptability all over the world, little

[1]Economics focuses on the allocation of available resources in a way that maximizes social welfare. It allows for tradeoffs among the tangible material goods to achieve the objective of social welfare. These tradeoffs are supposed to be efficient or Pareto optimal in economics jargon. However, economics ignore the fact that such Pareto-optimal allocation may lead to an unsustainable pattern of resource use and income distribution (Pearce, 1976). Most sustainable development proponents believe that basic assumptions of the conventional neoclassical framework are misfit to the natural world, and thereby question the assumptions related to the existence of natural externalities, possibility of prediction, the concept of discounting, and the equilibrium concept. Assumptions of traditional models can effectively solve the problems of short term allocative efficiency, but are not suitable to cater other important factors that affect human welfare. These factors are not confined to material goods but also include intangible environmental goods, prospect of a safer future that can be achieved by sustainable natural resource use (Daly, 1977; Hueting, 1980a, 1984).

[2]The focus of limits to growth was on the detrimental consequences of excessive growth process on the depletion of non-renewable resources such as minerals and energy and its associated effect for the continuity of growth process particularly in rich countries.

[3]The current study uses words sustainability and sustainable development interchangeably, without differentiating them.

headway appears to have been made in terms of the operationalization of the concept. The idea still seems unclear and differing interpretations have made it difficult to integrate into a practical guide for policy.

Economic literature offers a number of competing models to capture sustainability with varying degrees of variability and applicability. The question about which approach is closely related to capturing sustainability is far from consensus and opens for further exploration. The disagreements beg to address several areas: improving the clarity of the idea of sustainability, clarity of indicators used for gauging sustainability to encourage the empirical investigation of sustainability issues.

2.1.1 The Hypothesis of the Study

In light of the above discussion, the study aims to answer the following:

1. How to define sustainable development?
2. Summarize and synthesize the different theories encapsulating the economics of sustainability for understanding current knowledge about sustainability and highlighting the significance of new research.
3. Improve the clarity of sustainability indicators to encourage the empirical investigation of sustainability issues.
4. To give an empirical analysis of South Asian economies' sustainability situation.

2.1.2 Definition of Sustainability

Despite the widespread popularity and acceptance, the concept of sustainable development is vague and remarkably difficult to define precisely in a way that appeals to wide acceptance/broad consensus (Neumayer, 2003). A whole gallery of overlapping and conflicting definitions exists – so much so that Pezzey (1992) collected a plethora of different definitions of sustainability. Nonetheless, a definition that is acceptable by most economists is: development is deemed sustainable if it does not decrease the capacity to provide non-declining per capita utility or welfare for infinity. But what does it actually mean, and how to operationalize the concept? The answers to these questions lead to two contested variants of sustainability in economics (which will be discussed in the subsequent sections).

The present study defines Sustainable Development here as a non-declining utility (NDU) forever. In particular, an entire development path is 'sustained' if the utility of a representative person in the economy never declines along the entire path. In general, the definition focuses on intergenerational equity, which is the equity and fairness between present and future generations for the long-term decision-making of a society. It ignores any intra-generational issues that deal with equity among current generations. It does not mean that I do not realize or underestimate the importance of distributional issues for the sustainable development path. One of the reasons to ignore intra-generational distribution issues is to make the analysis easy and represent different generations by a representative agent of each generation (for an empirical analysis). Another reason to skip the distributional issue is to keep the discussion within the two chief paradigms of sustainability, as the centre concern of these paradigms is purely on the inter-generational issues. Literature on an economics perspective of sustainability has been so obsessed with intergenerational issues (with a particular focus on environmental sustainability) that it has swept the distributional issues within the current generation under the carpet (Heyes & Liston-Heyes, 1995). To maintain coherence, the analysis also omits sustainability issues related to any specific sector, such as agriculture, forestry, etc., thus taking a macro approach.

The mainstream approach of environmental economics (P. S. Dasgupta & Heal, 1979), the history of which is explored by (Klaassen & Opschoor, 1991), is based squarely within the neo-classical paradigm and is therefore subject to all the criticisms directed at neo-classical theory. In particular, the neo-classical assumptions of equilibrium, decreasing returns to scale, and rational economic actors are cosntested (Simon, 1978; Anderson et al., 1988; Arthur, 1994; Ormerod, 1994; Parker and Stacey, 1994;Trisoglio, 1995b). These criticisms tend to be ignored, however, in economic discussions of sustainability. A typical economic definition of sustainability is the "non-declining utility of a representative member of society" for some long time period into the future (Pezzey, 1989, 1992:323), which in turn requires that each generation should leave the next generation a stock of capital no less than it started with.

2.2 Theories of Sustainability

From an economics perspective, the issue of sustainability is framed in terms of maintenance or increase in some measures of human welfare for posterity (J. Pezzey, 1992; R. Solow, 1993). Human welfare, in turn, depends on the judicious combination of different forms of capital stock[4]that has the capacity for continuance. Since sustainability depends on maintaining different forms of capital, it immediately raises an important question, whether it is the total capital stock that matters and needs to be maintained, with substitution allowed between various parts of it, or whether particular forms of capital contribute to welfare in a unique way and cannot be substituted by other forms of capital, thus restricting unlimited substitution. This debate onthe degree of substitutability and relative importance of human and natural capital[5] inputs to the production and well-being of future generations has come to be known as two opposing paradigms in economics, i.e., weak and strong sustainability (Neumayer, 2003; D. Pearce, Turner, & O'Riordan, 1993; Turner, Pearce, & Bateman, 1994). The credit for this distinction presumably goes to (David William Pearce, et al., 1991). Four different categories of sustainability identified by Turner (1993) range from very weakto very strong sustainability, with the former assuming perfect substitutability while the latter envisages nosubstitutability at all. As the idea of sustainability is framed in two starkly different paradigms in economics, an understanding of these variants is vital. The following paragraphs analyze these competing paradigms of sustainability with the purpose of exploring their limits.

2.2.1 Weak Sustainability Paradigm

The mainstream economists' view on sustainability has come to be known as the weak sustainability paradigm. Weak sustainability (WS) is based on the notion that welfare does not depend on some particular forms of capital and can be maintained as long as the depletion of one type of capital is at least offset by increases in the other

[4] Capital stock includes conventionally defined man-made capital, human capital along with natural capital.

[5] Natural capital is classified into two major groups: (1) renewable resources and (2) non-renewable resources. Renewable resources can be further broken down into three components (a) forest resources (b) fisheries and (c) agricultural land, whereas non-renewable resources are decomposed into (d) fossil fuels and (e) minerals.

types. For example, a depleted natural resource (often known as natural capital) such as oil is substituted by investing in manufactured capital to sustain/maintain or increase well-being level over time. In simple words, WS requires a total net investment that encompasses all relevant forms of capital non-decreasing.

Advocates of WS assume that natural resources are abundant and a significant amount of substitutability is allowed between different productive inputs, different sources of instantaneous utility, and of utility at one time for another time (with a positive discount rate).[6]This assumption enables, theoretically, at least, to express the cost and benefit of such trade-offs in common units of value (J. C. Pezzey & Toman, 2002). The other important aspect of this view of sustainability is the use of representative agent fiction in the models to ignore the economic inequalities (intra-generational fairness),within a society and merely focus on the potential role of finite natural resources for inter-generational equity over several generations (J. C. Pezzey & Toman, 2002).

The pioneering work in the area of the economic theory of sustainability appeared in 1974, with the publication of three classic papers by Solow (1974) (R. M. Solow & Wan, 1976), Dasgupta and Heal (1974) (Partha & Geoffrey, 2017), and Stiglitz (1974) (JE Stiglitz, 1974). The aim of these publications was to challenge the doomsday prediction of the report '*Limits to growth'*, in which the depletion of exhaustible natural resources causes an absolute and imminent limit to economic growth (Donella Meadows, Meadows, Randers, & Behrens, 2014). Their work explored the conditions under which growth with a finite pool of exhaustible resources was possible instead of being ignored altogether, as they had been previously in the economic growth theory. In all three models, well-being over time is represented in terms of welfare maximization, and all models assume that natural resources are finite, non-renewable, and essential to production. Moreover, models assume that the elasticity of substitution between human-made and a natural resource is greater than

[6] Different variants of utility are used for measuring sustainability. One variant requires current social welfare or more technically instantaneous utility as non-declining to ensure country's sustainable path. In simple words, an economy is sustainable if it is potentially able to maintain the current consumption levels over time. Other variant of sustainability in terms of non-declining utility demands instantaneous utility not to rise above some reference level (assuming that such a level exists and is considered to be maximum sustainable). Another alternative relate sustainability in terms of non declining inter-temporal social welfare, means that the present value of future utilities must be non-declining.

or equal to unity via a Cobb–Douglas production function. The subsequent section summarizes the conclusions reached by this body of literature on sustainability. Their views on the possibility of achieving indefinite output growth (alternatively, the non-declining stream of consumption) with the presence of exhaustible resources fall under the framework of a weak sustainability paradigm.

The conceptual base of the theory was put forward by Dasgupta and Heal (P. Dasgupta & Heal, 1974). The authors explored the possibility of a continuous optimal growth path with exhaustible resources as an essential input in the standard neoclassical growth model. The model assumed the possibility of unconstraint substitution of natural capital for man-made capital. The objective was to find out an optimal growth path, which is to maximize the present discounted value of the representative agent's instantaneous utility with a positive and constant discount rate. The study used the constant elasticity of substitution (CES) production function. Dasgupta and Heal's 1974 analysis showed a gloomy picture for far-distant generations. The rate of consumption per head and utility are concentrated in the early years when resources are relatively abundant and eventually decline and approach zero (the economy collapses) in the very long run. This grim outcome is due to the use of a constant utility discount rate coupled with the scarcity of nonrenewable resources.[7] This conclusion, by any standard, does not represent sustainability.

The study of Stiglitz (1974) (JE Stiglitz, 1974) identified the conditions to avoid the undesirable outcome of Dasgupta and Heal's 1974 study. He introduced the role of exogenous technology in the model (instead of being ignored altogether, as in the case of Dasgupta and Heal's study) as a force to offset the limits to growth imposed by exhaustible resources. This view of 'technology optimism' is among the many variants within the WS advocates and holds that market forces will automatically

[7] Role of the ethically-based parameter (i.e., utility discount rate), which is a reflection of society's rate of impatience plays a crucial role in the debate of intergenerational equity. The "right" value of this parameter has long been a matter of debate.Many variants exist on how to incorporate it into the welfare functions to reflect the sustainability concern truly. The point of view of classical utilitarianism rejects the discounting of future welfare on moral grounds and implies that the same weight given to the utility of future people should be the same as received by current people.
Koopmans (1960), showed that the principle of no discounting leads to a highly inequitable outcome. See Farzin (2009) for detailed insight on this issue. Similarly, constant discount rate use by neoclassical utilitarianism in maximizing PV optimal path favors the current generations over or gives less weight to the future utility and hence results in grim outcome for the distant future.

ensure sustainability in the presence of large technological contributions in moderating natural resource scarcity. Therefore, with the possibility of technical progress, the productivity of natural capital improves,compensating for the diminishment of natural resources. Hence, increases in consumption per capita and utility are technically feasible in the long run.

The study of Solow (1974) takes a different route and gives a moral solution to the problem posed by Dasgupta and Heal's study. Solow based his inter-temporal equity criteria on Rawls' principle of the 'veil of ignorance' (or maximin principle),which is quite different from utilitarian Present discounted value (PV) optimality criteria.[8] The idea of the veil of ignorance was not originally explored in the context of sustainability and intergenerational questions. However, Solow (1974) and many others argued that, drawing on a similar idea, an individual would choose to ensure the maximization of the minimum realized consumption level. It implies that optimization is sensitive towards the well-being of the least well-off generation, thus known as the maximin principle. According to the maximin approach, the inter-temporal efficient outcome is permanent constant consumption per head or equal utility (well-being) at the maximum sustainable level for all generations. He showed that under certain conditions, constant well-being (or constant consumption) is possible with exhaustible natural resources, even when technical progress is absent. However, achieving a constant stream of well-being over time requires that the total capital stock is maintained. According to him, earlier generations could draw down a finite pool of resources as long as they offset the depletion of natural capital by reinvesting in the stock of reproducible capital, thus maintaining aggregate capital stock. Thus by assuming enough substitutability between natural and manufactured capital, constant population growth, and no technological progress, the optimal sustainable path is permanently constant consumption per capita in Solow's model.

[8]Throughout this thesis, the word PV-optimal will be used to describe the conventional growth policy of maximizing discounted present value (PV) over time. The Rawl's approach to social welfare, based on the idea of the 'veil of ignorance' highlights how to maximize the welfare of the least well off segments of the society. He argued that if society's justice principle were to be selected by individuals, then these principles need to improve the undesirable condition of the less privileged members of society. The utilitarian approach of PV optimality measures the social states (welfare) of society by adding up the utilities of all the individuals in a society. The utilitarian approach is more concerned about the maximization of general welfare and may allow the sacrifice of one person's good for the benefit of larger segment of society, while, the Rawlsian approach never permits such tradeoff.

His paper is one of the most widely read papers on the issue of sustainability, even though the word sustainability is not used in his paper.

The operational principle to achieve Solow's criterion of constant consumption for intergenerational equity[9] was put forward by Hartwick (1977). His work, as a direct extension of Solow's (1974) model, showed that maintaininga constant consumption stream over an infinite time horizon requires all rents and profits from resource depletion to be reinvested into human-made capital. In other words, rents equal exactly the level of capital investment required to maintain a constant stream of consumption. Also, the difference between resource rents and capital investment is known as net investment. The rule may also be read as forever zero net investment leads to forever constant consumption. In recent times, the Hartwick-Solow notion of the 'constant capital stock'[10] is commonly known as a *Weak sustainability approach*.

The maximin (constant utility) criterion of inter-temporal equity is a strict criterion, as it bans development that can raise future welfare in preference to one with constant welfare (J. Pezzey, 1992). According to this criterion, sustaining consumption per capita depends heavily on the country's initial endowment of the human-made capital stock. For developing countries with a low initial endowment of capital stock, this sustainability rule implies perpetuating the current poverty for posterity (Farzin, 2009).It also suffers from time asymmetry as future generations cannot be consulted in decisions about welfare. Pezzey (1989) put forward a concept of sustainedness ($U(t) \geq 0$ for all t), a modified constraint for sustainability, by using a maximin approach. The condition for intergenerational equity requires non-declining utility (welfare) over time instead of constant utility over time. Therefore, weak sustainability is defined as maintaining the capacity (aggregate capital stock) to provide a non-declining level of human well-being for infinity (Neumayer, 2003).

The weak sustainability approach is based on three basic assumptions:Resources are available in abundance, and the elasticity of substitution is

[9]'Equity' can be defined in different ways and it is normally associated with a system of justice and fairness. However, in the model of Solow and Hartwick, equity means an equal level of consumption, and hence utility.

[10]The 'constant capital rule' or 'weak sustainability rule' requires the current generations to pass on the aggregate capital stock to the next not less than what currently exists so that an economy's generalized productive capacity remains intact.

assumed to be unlimited between inputs. Also, believe that the current generation's investments in technology can overcome any resource constraint, just as earlier generations of the Western world invested in human and physical capital (such as education, equipment, and machines), science and technology so as to bequeath a large productive base that enabled current generations to achieve higher living standards. Due to the optimism that proponents of weak sustainability hold about the availability of resources and the ability of technological innovations to offset the increasing scarcity of natural capital, WS is also known as a paradigm of resource optimism (Neumayer, 2003).

Several other essays contributed to the theoretical debate on sustainability during this period. For example, (Krautkraemer, 1985) extended Dasgupta and Heal (1974) by adding environmental disamenity associated with the collective use of resources in analyzing the PV optimality problem. His results showed that in the presence of environmental disamenity (that puts a constraint on the economy to use less of resources than its entire available stock), the economy ended up with either clean or dirty resource use equilibrium. Krautkraemer's generalization of the PV optimality problem underscores the importance of environmental values to be considered along with direct consumption in the growth models studying sustainability. Another complex issue of the sustainability debate developed during this period is the moral underpinnings of intergenerational resource allocation. Some notable theoretical contributions(Norton, 1982; Parfit, 1983; Talbot, 1983). Norton (1982), Parfit (1983), and Page (1983) paved the way for considering moral criteria (such as concepts of environmental justice and stewardship) in the debate of intergenerational equity.

2.2.2 Strong Sustainability Paradigm

The paradigm of strong sustainability rests on the ideas of Ecological economics. It is based on a physical principle that is based on the thermodynamics laws. Advocates of strong sustainability (SS) reject the WS idea of unlimited substitutability between natural and other human-made capital. SS is a nature-centered paradigm, with special emphasis on the irreplaceable and unique contribution of natural capital to the welfare process. Herman Daly was an important architect who

marked the foundation of a strong sustainability paradigm in 1977 with the publication of his first book *Steady-state Economics* (1992). Many others have also contributed to the early development of the SS paradigm. Some notable contributions include (Daly and Coztanza,1992; Goodland and Daly,1992; Turner and Pearce,1992; Spash,1993 and Nogaard, 1988).

Strong sustainability treats natural capital separately and rejects the idea that ecological losses faced by future generations can be adequately compensated via an increase in consumption opportunities (Spash, 1993). SS proponents such as (Turner and Pearce, 1992; Pearce et al., 1994) pointed out combinations of factors to justify non-substitutability. Firstly, some environmental assets/nature provides some unique life support services and amenities that have effectively no substitute, also known as critical natural capital; therefore, the viability of such a critical form of capital must be ensured (Common and Perrings, 1992; Perrings, 1991). This is also known as the resilience of the ecosystem (ibid). Secondly, in case of loss of natural capital, irreversible harm or collapse can ensue. The irreversibility of natural capital is another important characteristic that differentiates it from manufactured capital. Manufactured capital, unlike natural capital, can be created, destroyed, and then can be created again in ways which is not possible for natural capital, such as living species. Thirdly, considerable risk, uncertainty, and ignorance exist about the damaging effect of depleting natural capital. As pointed out by Atkinson et al. (1997, p.4), risk, uncertainty, and ignorance are enough reasons to take a precautionary route before closing off options to future generations. In addition, SS recognizes natural capital as a complement to other forms of capital, including social capital, and, therefore, rejects the idea of unlimited substitution. This view is advocated by Daly (1990). SS is also known as the non-substitutability paradigm (Neumayer, 2003).

Strong sustainability has two differing interpretations in the literature, as identified by (Neumayer, 2003). One variant calls for the preservation of natural capital in value terms despite demanding the preservation of nature as it is. It allows unlimited substitution of non-renewable natural capital for a renewable form of natural

capital as long as the aggregate value of the stock of natural resources is constant.[11] To achieve that, it, however, requires reinvesting income received from the use of non-renewable natural capital such as oil and coal mines into the development of substitute renewable resources of equivalent value to maintain the total stock of natural capital intact (Hohmeyer, 1992). In general terms, Barbier etal. (1990) recommended that the extraction and depreciation of natural capital must be compensated by investment in so-called shadow projects.

The second strand of strong sustainability is not defined in terms of preservation in value but demands for preservation of the physical stock of all 'critical' natural capital that are non-substitutable (Ekins et al., 2003). This interpretation restricts trade-offs among different forms of critical natural capital. More generally, it implies that the total stock of natural capital remains constant over time (Daly, 1992a). However, it does not imply the preservation of every single asset, which is practically infeasible. It demands maintaining certain properties of the physical environment/certain functions of critical natural capital intact, which is the flow of these natural capitals, must not exceed their regenerative capacity[12] (Goodland, 1995). Several authors (Daly, 1992a; Costanza, 1991) put forward the following set of ecological rules to make strong sustainability an operational principle.

- The rate of harvest should not exceed regenerative rates (sustained yield).
- Use renewable resources in a quasi-sustainable manner so that their total stock is prevented from deterioration.
- Environment use as a sink for pollution should equal the natural assimilative capacities of the ecosystems.

The basic message given in the above paragraph is that the maintenance of the rate of regeneration and the assimilative capacity of the ecosystem is a stationary-state principle, also referred to as "very strong sustainability" (Turner et al., 1994; Hediger, 1999).Proponents of this paradigm are in favor of a more precautionary approach due

[11]For example, substituting non-renewable capital such as fossil fuels by wind farms in generating electricity (Neumayer, 2007).

[12] For example, the rate of soil erosion should not exceed the rate of soil formation (Hueting and Reijnders, 1998).

to pessimism about the availability of non-renewable resources and believe that stocks and throughput are limited by nature; hence the continuation of past levels of resource depletion is unsustainable into the future. For that reason, they strongly believe that there is a serious need to draw a line on humankind's use of the environment. They also tend to be quite pessimistic about the consequences of the growth process on the environment and call for a drastic shift in the basic understanding of the conventional framework, which envisioned macroeconomy as the 'whole' instead of a subsystem of the finite ecosystem (Daly, 1996, p.45). If the macroeconomy was not considered as a whole, but as a subsystem of a finite ecosystem, a query about the use of the optimal scale of the macro economy would have automatically popped up.Hence, modification to the scale of the economy (throughput of energy and matter) and realization of the threshold existence is a necessity to avoid catastrophe once thresholds are exceeded.

2.2.3 Concluding Remarks About Both Paradigms/Summary and Ways Forward

The above discussion about the opposing paradigms tells us that both paradigms are non-falsifiable. Both variants have their own pros and cons and rest on some assumptions and hypotheses about the distant future that is non-refutable under scientific standards (Neumayer, 2003). WS or resource optimism approach resting on assumptions of resource abundance, substitutability, and technological progress (time-driven or caused by investment), believe that any of these assumptions in isolation or some combination thereof is enough to keep the forces of resource depletion at bay and make conventionally optimal development sustainable. The propositions of resource optimistic are surely seem non-refutable given the success of the technical solutions in the past. However, these claims are definitely not certain, and the degree of uncertainty encourages agnosticism about the large claims of WS proponents. The empirical evidence about the degree of substitution assumed by WS proponents is ambiguous and does not plainly confirm the possibility of unlimited substitution between manufactured and natural capital(Neumayer, 2003).The actual level of substitutability of natural capital in the production of consumption goods is less-known than the apparent self-confidence with which advocates of WS and SS propagate their views (ibid). Given the pace at which non-renewable resources have been depleted, the continuity of plenty of capital-resource substitutability in the very

long run is extremely doubtful (Gerlagh & Van der Zwaan, 2002). The assumption of infinite resource availability in the future is also doubtful (Watkins, 2006).

Another problem with both paradigms is generality in claims about the substitutability assumption with no mention of specific and contingent cases (Dietz & Neumayer, 2007; Neumayer, 1999, 2003).Variants of SS or resource pessimistic paradigm theoretically focus on preserving critical natural capital but are remotely successful in distinguishing specific cases. The view of SS that natural capital should be considered as non- substitutable, as a direct argument of the utility function and that, therefore, environmental degradation cannot be compensated by an increase in the level of consumption is unacceptable from the lens of positive position and seems logical and undeniable if a normative position is taken (ibid). In order to make SS an operational paradigm that can guide policy actions, some sort of valuation of critical natural capital is needed. Without some sort of valuation, the preservation of all that natural capital that provides life support functions for humans will only remain a theoretical dream. The empirical research tackling the questions of sustainability is limited, and the reason behind the ambiguity regarding the claims of both paradigms(Victor, 2005). This highlights the importance of increased empirical research to explore the basic assumptions of both paradigms.

2.3 Indicators of Sustainability

The indicators for measuring sustainability need to be guided by a theory of sustainability. In the above paragraphs, the study discusses a theoretical framework related to two opposing paradigms of sustainability (e.g., weak and strong). In order to make these notions of sustainability an operational policy objective and to monitor how well the economy is performing on these criteria, measures of sustainability are necessary. The subsequent paragraphs are devoted to exploring different types of weak and strong sustainability indicators with their strengths and weaknesses to evaluate sustainability with accuracy.

As discussed earlier, sustainability is defined as a non-declining level of well-being in its indicator over time ((David W Pearce & Turner, 1990; J. Pezzey, 1989). Both approaches accept this definition of sustainability and its general implication as a non-declining welfare level for future people. The point of divergence is with respect

to the conditions required to achieve sustainability. Weak sustainability allows considerable substitutability between different forms of capital and requires maintenance of lump sum capital stock to sustain welfare. The focus of the WS measures tends to follow this basic theoretical principle and calculate the economic value of different welfare-associated capitals to compare the loss in value of natural capital consumption with other capital investments elsewhere in the economy. In contrast, strong sustainability requires the conservation of critical natural capital along with a constraint of non-decline in the overall capital stock for achieving sustainability.

In terms of indicators, then, SS will tend to emphasize environmental focus capital along with other forms of capital, whilst the focus of WS will be on the overall level of capital assets with no special highlighted measure for natural capital. The literature on green accounting is relatively large and diverse[13]. Although the common starting point of this literature is Gross domestic product (GDP), various adjustments in this common building block led to fundamentally different measures.

2.3.1 Indicators of Weak Sustainability

- Net National Product (NNP)

The initial step towards the development of the theory of indicators based on WS dates back to the emergence of literature on green national accounts. The literature arose out of concern about the insensitivity of standard national accounting aggregates to reflect the economic cost of depletion of environmental assets that may yield poor resource allocation and incorrect policy decisions. There are several criticisms attached to the traditional measures of economic performance. Some of them include; (i) standard indicators only take into account the good associated with production activities but ignore the bad such as pollution caused by production processes (ii) the accounts ignore the deletion and depreciation of environmental assets (iii) standard accounts do not incorporate environmental liabilities, such as accumulations of pollutants (Hamilton, 1995). In short, one overriding concern arising from the literature on the green national account is that the use of natural resources (reduction in the quantity of natural capital) and environmental degradation (damage to natural

[13]For a detailed analysis of different theoretical approaches, please see Atkinson et al. (1997).

capital quality) is not reflected in the standard measures of income and product flows and hence not well suited to gauge whether the economy is on the path of sustainability or not. It is on this basis that standard accounts enter the realm of green accounting. The literature on environmentally adjusted or green Net National Product (gNNP) has expanded vastly since the early influential empirical studies in this direction by Repetto and others (Repetto et al., 1989, Hartwick, 1990, Ahmed et al., 1989). NNP, since then, has undergone several adjustments to make it an exact measure of welfare, acknowledging the link between economic activity and the environment[14]. Some basic results from this theoretical work are set out below.

$$\text{gNNP} = \text{GNP} - \text{DP} + \text{RD} - \text{DEP} - \text{ED} \qquad (\mathbf{2.1})$$

where DP shows the depreciation of produced assets, RD is resource discovery, while DEP and ED represent the depletion of resources due to extraction and environmental degradation or damages, respectively (in other words, the combo of DEP and ED shows depreciation of natural capital asset consumption). Net resource rents are used in the accounting period to calculate the value of DEP, while ED is directly related to the accumulation of the stock of pollutants P, which in turn depends upon two factors, i.e., the amount of natural dissipation d (P) and pollution emissions 'e' related to the level of production[15].

The ability of the above resultant gNNP to serve as a true measure of well-being is contestable in the literature, and a number of interpretations exist. According to Solow (1993) and Weitzman (1995), green NNP is a suitable measure for evaluating the sustainable level of consumption and hence sustainability. This literature equates gNNP to Hicksian income, which is defined as the maximum amount of produced output that we can consume in the current period without reducing the consumption possibilities (or productive capacity) for posterity (Hicks, 1946). In this sense, rising green NNP is a sign of improvement in the sustainable consumption level and hence

[14] Though there exists a disagreement on precisely how to make these adjustments (such as expenditure on changes in pollution level) in standard accounts to become an exact measure of welfare. See Hamilton (1994) and Hanley (1997) for detailed analysis of different optimal adjustments.

[15]Net resource rent is the difference between resource extraction say R (out of the total stock denoted by S) and the rate at which that stock grows given by g(S). The equation for net resource rent is therefore, given by r(R-g).

Calculation of ED involves changes in pollution stocks, valued at marginal abatement costs.

indicates a sustainable path followed by the studied country (Hanley, 2000). However, many authors hold a skeptical view about the ability of green NNP to truly gauge and reflect the situation of sustainability. For example, Hamilton (1994) criticized on the ground that neither shifts in the income level entailed by gNNP nor its growth rate give any useful policy insight for sustainability. Moreover, it has subsequently been pointed out that weak sustainability cannot be measured conclusively by the use of an instantaneous measure such as gNNP; instead, the entire time path of gNNP needs to be assessed (Asheim, 1994; Aaheim and Nyborg, 1995; Pezzey and Withagen, 1995).The point of contention is the method used for measuring the depletion of natural resources valued as their Hoteling rents (that is, the difference between resource price and the marginal cost of extraction).Correctly measured rents to show the change in the resource stocks depend on correct shadow prices, as pointed out by Solow, Maler, and Hartwick. Nevertheless, as the path followed by the depletion of resources is not optimal; therefore, it is unlikely to be able to calculate optimal prices. In order to make gNNP as a true measure of sustainability, optimal or sustainable prices are needed. However, empirical work is based on available currently available prices that are non-optimal (PezzeyandToman, 2005). Moreover, the lack of data on marginal costs and abatement costs also makes it difficult to compute a good estimate of gNNP.

- Genuine Savings (GS)

Pearce and Atkinson (1993) put forward a stock-based measure (adjusted savings) of 'WS' based on the empirical application of the Hartwick rule for exhaustible resource-rich economies. This rule prescribes maintaining the aggregate capital stock by reinvesting the rents from the extraction of resources into produced capital. Pearce and Atkinson(1993) measure compares the saving rate against the sum of depreciation on manufactured and natural capital to test whether the aggregate capital stock is falling or not. If savings are greater than the sum of depreciation of two forms of capital, the economy can maintain a constant stream of consumption and follows a sustainable path and vice versa. This measure is based on the assumption of weak sustainability, as no specific conditions are imposed on the level of natural capital, and depletion of natural capital is permissible as long as rents are re-invested in other forms of capital to keep the total stock of wealth intact. Further extension and

modifications in this measure by Hamilton (1994) led to the concept of 'genuine savings.'The term 'genuine' was coined by Hamilton and refers to include all utility-related capital stock, such as social and human capital, along with natural and human-made capital to find out the genuine value of savings (Neumayer, 2003). GS is a monetary estimate of total wealth[16] and is based on a utilitarian framework discounted at a constant rate, with constant population[17], and allows sufficient substitutability between different forms of capital(Neumayer, 2003). GS rates depict the extent to which total resources are added or depleted in an economy. Positive GS is an indication of additions in total capital stock, while the value of GS inferior to zero shows an unsustainable path followed by an economy (Pezzey and Toman, 2002b). The reliability of GS as a good predictor of sustainability is contestable. Some debatable issues include; the inability of GS to give any information on the intra-generational aspects of sustainability and confined only to the inter-generational dimension. The other point of contention is operationalizing the theoretical approach of GS. It is assumed theoretically that the economy follows an inter-temporally efficient growth path which means the existence of well-defined property rights (or absence of any externalities), rational agents with a complete set of information, and perfect functioning markets. In reality, the path followed by an economy is not efficient due to many market failures and negative externalities that affect natural resources in the absence of well-defined property rights. Therefore, neither the depletion of the resource stock nor the current observed prices are optimal (Pezzey and Toman, 2005). Hence, in the absence of shadow prices (that precisely reflect the inter-temporally efficient resources depletion path, that is, depletion of resources equal harvest plan for resources), positive trends in GS may not be a reflection of the sustainable path and can go in hand with non-optimal resource exploitation and environmental degradation

[16]World Bank uses following definition of total wealth (GS) for accounting framework:
GS = Gross national savings – depreciation of produced capital (fixed capital consumption) + current education expenditures/ investments in capital from human resources (where this last term captures human, institutional and social capital) −value of natural resources depletion (estimate include resource depletion of range of fossil fuels, minerals and non- renewable asset such as forest) – the value of environmental degradation (carbon dioxide emissions and particulate matter emissions).

[17]There is an emerging literature on how to incorporate the population in the calculation of GS. Hamilton (2003) gave a simple way to adjust population growth by sampling dividing GS with population to give per capita GS. While there is a disagreement on this issue. Dasgupta (2001) and Arrow etal (2003) treated the population as a separate asset to show additional pressure of change in population on re-sources.

(Pearce and Turner, 1989; Dietz and Neumayer, 1999). Given these constraints, some economists still believe that the values of GS may not accurately reflect the magnitude but can point/predict the sign in the right direction (Hamilton, 1997; Ferreira and Vincet, 2005).

- Index of Sustainable Economic Welfare or Genuine Progress Indicator

In order to give a better measure of current welfare and sustainability, Daly and Cobb (1989) developed a competing indicator of WS, known as an index of sustainable economic welfare (ISWE), that has become the Genuine Progress Indicator (GPI) after successive modifications by Cobb et al. (1995).[18] It was developed to integrate missing welfare ingredients such as income inequality, environmental degradation, defensive expenditure to offset environmental damages, and values of unpaid household labor in the calculation of GNP/GDP to better reflect the situation of current welfare and sustainability.[19] It is one of the pioneering indicators to include the aspects of social welfare in conventional welfare accounting. The rising value of ISEW/GPI shows an improvement in economic welfare. Empirical studies based on this indicator show that ISWE/GPI grows more slowly than GDP/GNP, and it has even fallen in most cases. Max-Neef(1995) put forward a 'threshold hypothesis' as an explanation for this increasing divergence between ISWE/GPI and GNP/GDP. According to this hypothesis, for every economy, there is a point beyond which conventional measure of economic growth, such as GDP/GNP, does not improve the quality of life but actually deteriorates it. The indicator is criticized for the lack of any clear theoretical foundation for justifying social and environmental adjustments in conventional measures. Most of these adjustments are ad hoc and based on arbitrary weights. The concept of defensive expenditures is one prominent example in this regard. Early ISWE/GPI studies gave little importance to education expenditures for productivity and often excluded a major chunk (50%) of the education expenditure from the

[18] The difference between ISEW and GPI stems from some revisions in the computation method such as the exclusion of defensive expenditure on health and education from GPI and inclusion of a value for loss of leisure time, the cost estimate of underemployment and loss of forest.

[19] For more details on the concept and methodologies behind ISEW, see (Jackson and Marks, 1994; Neumayer (2000a); Clarke and Islam (2005).

ISEW= personal consumption expenditures divided by an index of income inequality+ add expenditure for household labour services and voluntary work + public and private defensive expenditure on health and education

calculation. This adjustment is clearly in stark contrast to what economists believe about the importance and contribution of education to the growth process (Neumayer, 2003). Along similar lines, Daly and Cobb (1994) also declared 50% of the health expenditures as 'defensive'[20]; that is, it protects individuals against the unwanted decline in welfare due to other socio-economic activity and is therefore excluded from welfare accounting. Following Daly and Cobb's (1994) definition of the term defensive, some other expenditures, such as food, entertainment, and holiday expenditures, also qualify for the 'defensive' category. Thus, the indicator clearly lacks to give an objective answer for what should be counted as defensive (Neumayer, 2003). Responding to this fundamental criticism, recent ISWE/GPI studies do not subtract controversial education expenditures from defensive expenditures.[21] Also, like gNNP, ISEW/GPI is a flow measure and therefore is not perfectly suitable to gauge the situation of sustainability as sustainability decision needs to be based on total productive capacity rather than a change in a year.

2.3.2 Indicators of Strong Sustainability

- Ecological Footprints

In order to give a better measure of current welfare and sustainability, Daly and Ecological Footprints is a physical measure of strong sustainability and was first proposed and developed by Rees and Wackernagel (1994) and Wackernagel and Rees (1996). Its objective is to measure the environmental impacts of human economic activity into the total land area of ecosystems required to supply the resources a human population consumes and to absorb the associated waste, both locally and elsewhere (Wackernagel and Rees, 1996), subject to the production practices in any given year (Wackernagel etal., 2002). One distinguishing feature of this indicator is its focus on the 'consumption perspective,' and the consumer is deemed responsible for creating an ecological footprint; hence required land area is ascribed to the consumer rather than the producer. It means that things produced in a developing country but exported to a developed country would count towards the ecological footprint of importing

[20]Defensive as defined by Daly and Cobb (1989) is the defense against the adverse consequences of other socio economic activity.
[21] For further details, see redefining progress (2006).

country. This is clearly at odds with the indicator of WS such as GS, which takes a 'production perspective' 22 and where extracting country is held responsible for maintaining a positive GS. Taking into the spirit of SS, the unit of accounting used in the ecological footprint is land rather than money. It compares the existing bioproductive land area necessary to support the *consumption* activities for a given population. If the ecological footprint is higher than the existing bioproductive land area, then it implies that more land is required than actually exists to support the rate at which humans are consuming resources, and the current economic activity is not sustainable. The positive foot print is known as ecological deficit and indicates exceeding carrying capacity of the land area either due to depletion of the country's natural capital or that the country's consumption creates an ecological footprint on other countries via import. The measure of ecological footprint includes estimates of energy, food, and timber consumption23demand per capita in terms of the required land area to produce these amounts. The sum is then compared with the land area needed to produce these items to conclude about sustainability. Although this is one of the most influential and widespread indicators, it is not perfect and has encountered criticism. Despite the popularity of the measure of ecological footprint in empirical analysis, it has some limitations. Firstly, this indicator is not robust to technological improvements such as advances in waste treatment or improvement in ways to carbon sequesters and thereby is not vigorous to policy changes that prompt such responses (J. C. Pezzey & Burke). Secondly, EF omits saving and depletion of nonrenewable resources altogether, thus, leaving out an important aspect required for an overall assessment of sustainability (ibid). Third, the indicator does not include all aspects of the economic activities that affect ecological capacity due to a lack of means to convert into physical units (Neumayer, 2003). Last but not least, this measure fails in terms of redirecting policy and as a predictive measure(Ayres, 2000).

[22]For a detail discussion of consumption and production perspective, (see Peter and Hertwich, 2008; Lenzen andMurray, 2010).

[23] Calculations of food and timber foot prints include (i) land area required to produce items such as food and fibre, livestock grain, oil and rubber. (ii) Area required for timber harvesting for wood. (iii)land area required for animal grazing to provide meat, milk, wool etc.(iv) The amount of the land paved over or used due to housing, transportation and so forth.(v)fishing in freshwaters (Neumayer,2003).
Energy footprint is calculated as the hypothetical amount of forest required to sequester carbon from the atmosphere or land area required to provide renewable energy instead of fossil fuelsto sequester the greenhouse gas emission.(Neumayer,2003)

2.4 Concluding Remarks about Indicators of Sustainability

The above discussion about the different indicators highlights the fact that no one indicator is complete and sufficient enough to fully gauge the sustainability situation of any economy and should be taken with caution. The basic principle underlying the above-mentioned indicators of sustainability is the same, except for Ecological Footprints,which are based on the concept of ecological carrying capacity.

There are difficulties in fully operationalizing the theoretical literature on sustainability due to various constraints. Data limitations constrain to include all forms of natural capital for empirical analysis, particularly in the case of developing countries. As a result, most of the recent work in the field of sustainability economics has remained theory-rich and data-poor (J. C. Pezzey & Toman, 2002). Markets for natural and social capital do not exist, which makes it difficult to reflect the true price of these capitals. One of the important components of human capital is health and is not included in any of the above-mentioned indicators. Multiple international organizations, such as the World Bank and United Nations (UN), are committed to overcoming these problems and continuously improving data quality and coverage.

2.5 A Cross- Country Analysis

This section of the thesis presents the cross-country analysis by using indicators of the two opposing paradigms of sustainability. Empirical analysis surely looms large in giving a clear picture of the nature of the problem and in guiding different response options.The literature summarized in the previous section gives an overview of the background, need, and concept of sustainability, along with the different indicators to measure sustainability. Here, we just give a brief insight on the aforementioned topics. This part of the study has five sections. First, we discuss the motivations for the idea of sustainable development. Second, we briefly explain what definition of sustainability we are using, and then we discuss in detail the selected indicators for measuring sustainability and the rationale behind their use. Finally, we explain the cross-country differences among the selected sample.

2.5.1 Need and Importance of Analysis

Economic activity has expanded many folds since the start of the industrial revolution. The global growth experience since then has impacted societies and the planet both positively and negatively. Average living standards have seen the greatest leap due to improvements in health, education, and increases in per capita income(Malik, 2013; Polasky, et al., 2015). However, continuous economic expansions have detrimental effects on the stocks of natural capital, and consequently lead to the loss of biodiversity, climate change, and environmental degradation (Reid, et al., 2005). However, economics has, until recently, been detached from the environment and considered the environment as a subset of the economy and seesnature, at best, as a source of raw materials and as a sink for waste assimilation (P. Dasgupta, 2007). Economists believe in never-ending growth due to the underlying implicit assumption that the resource base upon which this growth depends is infinite. Due to this narrow view held by economists, the resource stocks are drawn at a rate faster than they can be replenished and pollution is emitted beyond the earth's assimilative capacity.

The debate on the link between human-led economic activities and the environment started to earn popularity in the late 1960s with the seminal works of certain interdisciplinary experts. Some key contributions include Boulding's essay on the spaceship earth (Boulding, 1966), followed by more intricate efforts by authors such as(Ayres & Kneese, 1969; Daly, 1968; Georgescu; Kneese). Although diverse in the subject matter, these studies have shown that the economy and environment are interrelated topics, and given the finite capacity of the planet Earth, limitless growth is not possible. Therefore, there is a need of urgency to take into account humanity's use of environmental and natural resources in economic decisions making if future generations are to be saved from any detrimental consequences. The debate opened up the space of critique that paved the way for several strands of literature on sustainability (Røpke, 2004).The issue remained highly contested until the development of the idea of sustainable development, by which debate was politically settled. Sustainable development is concerned with balancing the current process of economic growth and resource usage for posterity or, in economics jargon, demands

inter-generational equity (Beckerman, 1994). Achieving intergenerational equity requires each generation to bequeath its progeny at least as much capital stock as it had itself inherited from its predecessor(Figge, 2005). Since sustainability depends on maintaining different forms of capital,the operational application of this capital approach to sustainability led to the two opposing paradigms of weak and strong sustainability. Both paradigms have completely differing beliefs about which forms of capital are crucial for ensuring sustainability. Weak sustainability is based on the prevailing theories of environmental economics. According to the Weak paradigm, non-declining well-being requires the maintenance of an aggregate capital stock with substitutability allowed among different forms of capital.While strong sustainability stems from the Ecological economics. It focuses on natural capital and requires maintenance of the natural capital stock for ensuring well-being overtime. This paradigm is against the idea of unlimited substitutability and highlights the contribution of particular form of capital for human's well-being (Daly, 1990; Neumayer, 2003; D. Pearce, et al., 1993; Turner, et al., 1994).

Despite the widespread support and popularity of the concept of sustainable development all over the world, little headway appears to have been made in terms of the operationalization of the concept. There is very little empirical evidence to validate that the world economies are on a path of sustainability. Indeed, the Agenda 21 document of the United Nations conference on environment and development emphasized the use of the indicators of sustainable development in order to inform policy and decision-makers to duly gauge whether their economies are on a sustainable path (Environment, 1992; Weiss, 1992).

The purpose of the current study is to present some empirical evidence of the ways in which different indicators of sustainability have changed for the South Asian economies spanning over the period 1990-2018. Until now, a handful of studies have analyzed the sustainability situation of Asia. For example, the study of (Barua & Khataniar, 2016) used the indicators of both weak (genuine savings) and strong sustainability (Ecological footprint) to gauge the sustainability situation ofselected Southeast Asian countries. The study does not take into account the population and technological changes over time. The assumption of the constant population does not fit well for developing economies. The population has grown everywhere, and the

South Asian region is no exception. It is actually one of the fastest-growing population regions in the world, representing 24% of the world's population (United Nations & Social Affairs, 2015). Without accounting for population changes, results about sustainability can be highly misleading. In another study, (Chang, Tan, & Chen, 2015) used modified indicators of weak sustainability (genuine saving) by incorporating both population growth and technology to give a more realistic and less contentious picture of sustainability. The study was carried out for selected East Asian economies and results indicate the indicator sensitivity towards population and technological progress changes. In another analysis, (Galli, et al., 2012) traced the movement in Ecological footprint for India and China and showed that growingconsumptionis pushing the economies to use nature beyond its assimilative capacity.

The current analysis is unique in the sense that it uses 'inclusive wealth' as an indicator of social progress and human welfare. Inclusive wealth is a way more comprehensive measure than the genuine savings used by the above-mentioned studies due to the following reasons. First, in contrast to genuine savings and for the sake of better reflection of reality, the inclusive wealth indicator is not based on the assumption of optimal allocation or inter-temporal efficiency(Thiry & Roman, 2014). Taking away the assumptions of optimal allocation and inter-temporal efficiency makes this indicator more relevant and suitable for non-optimal developing economies. Second, the GS was criticized for its inability to take into account the effects of changes in future terms of trade of trading countries. For instance, if there is a spike in resource rents(oil price) of the exporting country, then the terms of trade of the resource exporting country will be improved, and the resource importing country tends to experience a deterioration than what was initially predicted (Dietz & Neumayer, 2006).In an account of this criticism, adjusted net oil gains are included in the inclusive wealth indicator. Third, genuine savings was criticized for being unable to capture the pressure of population growth for measuring a country's track of sustainable development. In comparison, inclusive wealth informs about the impact of population growth on sustainability (UNU-IHDP., 2012). Finally, inclusive wealth uses a broader range of natural capital than GS. All these factors make inclusive wealth a more comprehensive measure and more suitable to measure the sustainability situation of economies. By conducting a trend analysis of the inclusive wealth patterns for the

selected region, the study seeks to find out the sustainability of the social-economic-ecological system of the selected countries. To measure countries' scores from the ecological economics or strong sustainability perspective, the analysis uses an indicator of Ecological footprint.

2.6 Framework of Weak Sustainability Measurement

As mentioned earlier, the phrase "sustainable development" came into common use/popular usage after it was formally inaugurated in 1987 with the publication of the report 'Our Common Future' also known as the 'Brundtland report' by the UN World Commission on Environment and Development (WECD). The report defines sustainable development as a global challenge that calls for a progressive transformation of our economies, such as to meet the needs and aspirations of the present generation without making future generations impoverish (WCED, 1987). The report is an effective document in terms of global consensus for achieving sustainability. However, it falls short of providing a clear suggestion as to how to evaluate the progress in a quantifiable way that can guide policy makers to take appropriate actions.

In some sense, the concept of sustainable development is vague and notoriously difficult to define precisely in a way that commands universal/broad agreement (Neumayer, 2003). Pezzey (1992) collected a wide gallery of different definitions of sustainability. One of the first variants of sustainability was Solow's idea of '*forever constant utility'*(R. M. Solow, 1974), which was based on the Rawls theory of justice (Rawls, 1971). The subsequent revisions led to the idea of '*non- declining utility over time'*(J. Pezzey, 1989) and '*forever non-declining inter-temporal welfare'*(P. Dasgupta & Mäler, 2000).

The specific formulation use in this thesis, for the sake of weak sustainability, is premised on the body of several theoretical works on measuring sustainability, especially under imperfect economies (K. J. Arrow, Dasgupta, Goulder, Mumford, & Oleson, 2013; P. Dasgupta, 2009; Hulten, 1992). Sustainability, defined as intertemporal well-being[24] (social welfare) at time t denoted as V (t), is given by:

[24] Well-being, utility and welfare are used interchangeably in this thesis.

$$V(t) = \int_{t}^{\infty} [\, U\big(C(s)e^{\beta(t-s)}\big]ds, \beta \geq 0 \qquad (\mathbf{2.2})$$

where $(C(s))$ represents a vector of consumption flows (goods and services) at time $s(where, s \geq t)$ and β is the discount rate. The above expression defines the economy's objective of sustainability as a present discounted sum of the flow of future utilities $U(C(s))$ over infinite streams beginning at time t. For a development to be sustainable, V(t) (sometimes called intertemporal social welfare) must be non-declining over time. This allows for a short-term decline in the instantaneous level of consumption, but such declines need to be offset by a sufficient increase in future consumption to ensure the non-declining present value of future utilities(P. Dasgupta & Mäler, 2000). To make the operational sense of this definition, the current framework is based on the central assumption that intertemporal well-being is a function of capital assets or wealth (means to achieve ends, that is, well-being) of the economy. The stock of capital offers the economy's potential streams of goods and services over time; the more the stock of capital assets, the more lasting the potential stream (Managi, 2019).Thus, denoting three different forms of capital assets (produced, human, and natural capital) as PC, *H*C, and *N*C respectively, the equation giving equivalence between wealth[25] and well-being is given by:

$$W(PC, HC, NC, t) = V(t) = \int_{t}^{\infty} [\, U\big(C(s)e^{\beta(t-s)}\big]ds, \qquad (\mathbf{2.3})$$

[25] The question of measuring sustainability has long been central to this focus. There is a growing consensus that the sustainability can be better understood and measured by using the comprehensive stock measure such as wealth ((K. J. Arrow, Dasgupta, Goulder, Mumford, & Oleson, 2010; Stiglitz, Sen, & Fitoussi, 2009)). It grew out of the concern that the results based on the currently available measures of national accounts (due to their incompleteness) can be translated into wrong policy errors. The very first efforts to posit a link between sustainability and wealth was proposed by Pearce and Atkinson (1993).

where W is inclusive wealth (IW). [26] Inclusive wealth (IW) avoids an assumption of production optimality constraint imposed by standard growth theory[27]. It instead relies on a general resource allocation mechanism that produces output given capital and predicts the future capital stock K(s), future consumption C(s), and thereby future utility U(s) on the basis of the existing capital stock and evolving structure of technology or knowledge without any assumption of Pareto optimality(K. J. Arrow, Dasgupta, Goulder, Mumford, & Oleson, 2012; Harris & Pearson, 2004).This mechanism helps us to move from intergenerationalwell-being V(t) defined in terms of future utilities to a wealth function that depends on the current capital stock and resource allocation mechanism. Equation (2) can alternatively be written as:

$$W(t) = V((K(t), t) = V(t) \qquad (\mathbf{2.4})$$

The fact that V (t) not only depends on K (t) but also on time t indicates the exogenous effects of time-varying factors on wealth and, alternatively, well-being. Inclusive wealth is measured by the multiplication of the current stocks of capital to their shadow prices.Assuming that V (t) is differentiable in $\underline{K}$ (vector of capital stocks), the shadow price of the *ith* capital good K_i at time t is defined as follows:

$$pi(t) = \frac{\partial V(K(t), t)}{\partial Ki(t)} \equiv \frac{\partial V(t)}{\partial Ki(t)} \qquad (\mathbf{2.5})$$

The shadow prices *pi(t)* reflects the marginal contribution made by the stock of *ith* capital asset to V(t) both directly and indirectly. The shadow price of the capital

[26]The Inclusive Wealth index reflects the social worth (accounting value) of the economy's productive potential and the stream of goods and services that this entire stock of assets can provide over time. It links the present discounted value of all future consumption possibilities to the net change in the value of total capital assets in an economy, even if the economy is not following an optimal path (Dasgupta 2009). Therefore, combination of three capitals leads to achieve the ultimate objective of promoting social well-being of an economy. As production function includes these three capitals; thus, they are also known as the productive base of the economy. Inputs in the production function or productive base has evolved over the time; classical economists included the input trio of physical capital, labor and land in the production function, the neoclassical economics has focused only on capital and labor. Subsequently, the literature evolved after growing realization of depletion of the non-renewable resources and treated capital and exhaustible resources in the production function (Dasgupta and Heal 1974; Solow 1974). In conventional economics, the role of human capital for the process of economic growth is recognized and efforts are made to define and measure the value of human capital (Mankiw et al. 1992). The final step to attain the sufficiently broad set of capital stocks is the inclusion of natural capital. Comprehensive set of productive base is imperative for studying and measuring the sustainability of human well-being.

[27] Production process assumes both technical and economic efficiency assuming that economy is on the production frontier and maximizes in the presence of perfectly competitive markets.

asset today depends not only on the date in question but on the entire future of the economy. It reflects the present discounted value of perturbation to utility due to incremental changes in assets today(K. J. Arrow, et al., 2012). This implies that shadow prices are supposed to reflect future scarcities of any type ofcapital (ibid.).

Finally, the condition required for the development to be sustained is

$$\frac{dV(t)}{dt} \geq 0 \qquad (\mathbf{2.6})$$

therefore, intergenerational well-being reflected by social welfare at any point must be non-declining. Differentiating equation (3) w.r.t to time and combining constraint given in equation (5), we have

$$\frac{dV(t)}{dt} = \frac{\partial V}{\partial t} + \sum i \left[(\partial V(t)/\partial Ki(t))(dK(t)/dt)\right] \geq 0 \qquad \mathbf{(2.7)}$$

Plugging equation (4) in the above equation, we have

$$\frac{dV(t)}{dt} = \frac{\partial V}{\partial t} + \sum i \left[pi(t)\left(\frac{dKi(t)}{dt}\right)\right] \geq 0 \qquad (\mathbf{2.8})$$

The first term on the right-hand side of the above equation reflects the accounting of the exogenous influences on social welfare through the passage of time. The second term is genuine investment which is an indication of the economy's choices with regard to converting the output into capital restoration and accumulation over time.

Finally, by comparing and estimating the change in total wealth at two different points in time, the sustainability situation (from the perspective of weak sustainability) can be assessedgiven the assumption that the process of resource allocation followed over this time period is sustainable if inclusive wealth is positive (Walker, et al., 2010). Therefore, the proposition is that an increase (decrease) in inclusive wealth will increase (decrease) the social well-being of the economy (no matter what the cause of that increase (decrease) is).

2.7 Results and Discussions

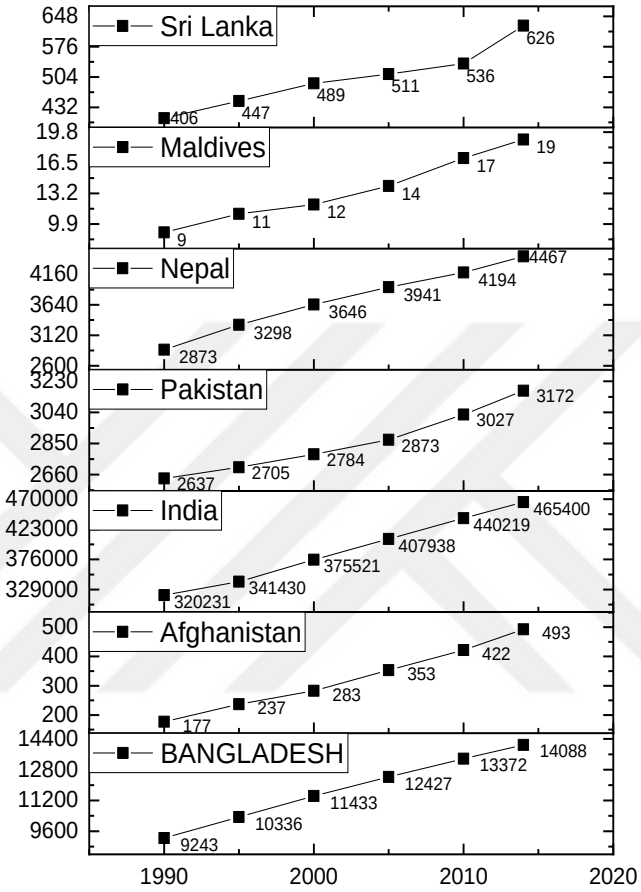
2.7.1 Environmental Concerns in South Asia

South Asia is one of the most densely populatedregions in the world and accounts for more than a quarter of the world's population, and together they are also one of the most rapidly growing economies in the world(Salgado & Kihara, 2019). Since the mid-1980s, successful growth strategies have led to a steadyrise in real GDP growth from an average of about 3% in the 1970s to 7% over the last decade (ibid).The combined economies of the region contribute 3.3% of the global GDP (Kaneda, Dupuis, & Bietsch, 2015). The impressive economic growth has enabled to lift over 200 million people out of poverty in the last three decades, thus reducing poverty and increasing social welfare(Chung & Lee, 2005).However, South Asia's rapid industrial and economic growth has largely been fueled by the heavy exploitation of natural resources, thus, placing enormous pressure on the environmental sustainability of the region (Jha, 2005). The fragility of the physical environment of the region is visible in several ways. For example, almost half of South Asia's land and forest areas have been degraded in one way or another(Shihab, 1997). The water resource base is under serious threat due to over-exploitation, as South Asian economies such as Bangladesh, India, and Pakistan are the largest consumers in terms of water use(Smith & Jalal, 2000). Climate change is likely to have a significant impact on the region. Asia is the largest victim of the world's major natural disasters, as about 75% of the catastrophes between 1970- 1997 occurred in the Asian region (ESCAP and ADB, 2000).The high population growth rate of the region is also a major concern and further hampers the sustainability of the region.

Against that backdrop, the next section provides an overview of the sustainability situation of six South Asian countries, namely Srilanka, Pakistan, Nepal, Maldives, India, Bangladesh, and Afghanistan, by using indicators of inclusive wealth index and Ecological footprint for weak and strong sustainability respectively. Bhutan is excluded due to the unavailability of the data.To the best of our knowledge, those two indicators have not been studied together before in any other study using time series data, specifically for the selected Asian countries. The time series data considered for this study are for the period between 1990 and 2014 for each country under study.

Secondary data are taken from the Inclusive wealth reports 2014 and 2018 and the Global Footprint Network database (GFN, 2012).

2.7.2 Inclusive Wealth Growth in South Asia

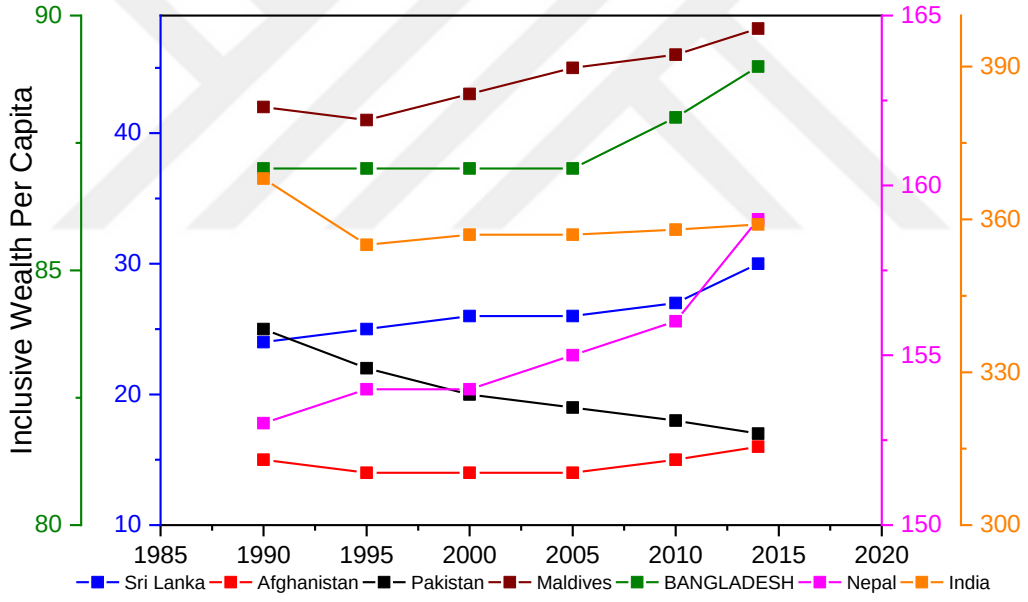


Source:UNU-IHDP and UNEP (2018)

Figure 2.1. Wealth (Inclusive wealth in billions of constant 2005 US$)

Figure 2.1 shows the changes in inclusive wealth for the selected South Asian economies. It shows a promising performance of all the countries. India has the highest share in the inclusive wealth of South Asian economies, followed by Pakistan and Nepal. Although countries varied significantly in terms of the magnitude of growth in inclusive wealth, all countries showed a strong positive trend between 1990 and 2014. However, the results shown in figure 2.1 should be interpreted with care as it has limited explanatory power in terms of inter-generational equity. An increase in total wealth does not necessarily fulfill the sustainability criterion of having sustainable

consumption paths followed by a country. It is quite possible that future generations may not be able to enjoy the same level of consumption as the present one simply because the population is not constant. As the population grows, the fruits of each form of capital are thinly spread among the population,and productivity growth based on capital accumulation alone might cease in the long run (Managi & Kumar, 2018). Therefore, the wealth per capita estimate provides a better picture of social welfare and a correct index for policy analysis (K. Arrow, et al., 2004; P. Dasgupta, 2001).To demonstrate a more realistic and less contentious evaluation of sustainability, figure 2 provides an analysis of wealth per capita trends of the countries relative to their population growth.



Source:UNU-IHDP and UNEP (2018)

Figure 2.2: Wealth (Inclusive wealth per capita in billions of constant 2005 US$)

After factoring in population growth rates, the status of some countries shifted from sustainable to unsustainable, as wealth per capita turned negative for these countries. The figure shows a declining trend for three out of six countries, while the remaining three are marginally sustainable. There is a significant reduction in the

magnitude of wealth per capita growth rate than the growth in absolute terms. For example, India showed a promising inclusive wealth growth of 2.92 but could not manage to have positive per capita wealth. It shows that India's population growth rate outpaced the growth in wealth per capita. As a result, India is depleting its productive base and has a weaker base than it had in the 1990s. Pakistan is the worst performing among all the South Asian countries as it moved to an unsustainable path due to negative per-capita wealth. This fall in per capita wealth is mainly due to the high population growth rate (the population growth rate is highest in Pakistan among the selected region). These results also highlight the importance of factoring in population while talking about the sustainability trajectory followed by an economy. Therefore, these countries are not satisfying the weak sustainability criteria of non-declining wealth per-capita.

Other countries in the group, such as Bangladesh and Maldives, manage to have a sustainable path, primarily by growing their human and produced capital in compensation for the rundown of their natural capital stock. These countries follow a modest sustainable trajectory under a weak sustainability criterion. To find out the other factors that could affect the inclusive wealth per capita growth other than population, the study finds the correlation between the growth of inclusive wealth per capita and other related factors by using data from ninety-eight developing countries included in the report for the period 1990-2014.Considering the relationship between economic activity and the sustainability of a country, the study considers per capita GDP and the growth rate of GDP per capita as related factors. Following the study of Yamaguchi et al. (2019), the study also includes the composition of wealth (share of physical, human, and natural capital) as related factors affecting IW per capita.

Table 2.1: Correlation between IW per capita growth and the related factors

	IW per capita growth	1	2	3	4	5
Per capita GDP	0.39***	1.00				
Per capita GDP growth	0.30***	0.06	1.00			
Physical capital share	0.46***	0.69**	0.16*	1.00		
Human capital share	0.23***	-0.56***	-0.08	-0.60**	1.00	
Natural capital share	-0.51***	0.19**	-0.02	0.11	-0.88***	1.00

*** p<0.01, ** p<0.05, * p<0.1 shows the level of significance at 1%,5%v and 10% respectively.

The correlation results show that the share of natural capital is negatively correlated with the growth of IW per capita. The stronger correlation coefficient (which is -0.51) indicates that the more the share of the natural capital of a country in its wealth composition, the more difficult it is for that country to maintain the trajectory of sustainable development or, in other words, to sustain a positive growth rate of IW per capita. Another related factor that has a high correlation (0.39) with inclusive wealth per capita is GDP per capita. Another noticeable factor is physical capital share, with a correlation coefficient of 0.46; however, the study uses GDP per capita asa substitute for physical capital because of the high correlation between GDP per capita and physical capital share.

Based on the above results, the current study uses GDP per capita and share of natural capital as factors that affect IW per capita. To make the analysis concise, in the first step, the study groups South Asian countries on the basis of their degree of natural

capital share in total wealth and then discusses the result from the GDP per capita point of view. The following table divides the countries in the South Asian region into two groups (countries having more than 30% share of natural capital in total wealth are categorized in one group while others are categorized as low natural capital share countries).

Table 2.2: Grouping of South Asian countries on the basis of the share of natural capital share

	Country	Natural Capital share (as of 1990)	Physical Capital share (as of 1990)	Human Capital share (as of 1990)	Natural Capital share (as of 2018)	Physical Capital share (as of 2018)	Human Capital share (as of 2018)	Inclusive wealth per capita (as of	Inclusive wealth per capita as of	Compound growth rate of
Low Natural capital share countries	Afghanistan	6.8%	14.2 %	79%	9.5%	5.8%	85%	15	16	0.65 %
	Bangladesh	0.67 %	0.57 %	98.5 %	0.36 %	1.85 %	97.7%	87	89	0.23 %
	Nepal	7.7%	0.31 %	92%	3.8%	0.69 %	95.5%	153	159	0.38 %
	Srilanka	19.5 %	9.6%	72%	10.1 %	18%	71,2%	24	30	2.25 %
High Natural capital Share Countries	India	31.1 %	7.5%	61.4 %	15.1 %	23.5 %	61.5%	368	359	-0.24 %
	Maldives	33.3 %	11.1 %	55.5 %	10.5 %	26.3%	63.1%	48	42	1.00 %
	Pakistan	55%	6%	39%	23.5 %	10.68%	65%	25	17	-3.78 %

Note: Author's own calculation

The low natural capital share group includes Afghanistan, Bangladesh, Nepal, and Srilanka, while, while the high Natural Capital share group comprises India, Maldives, and Pakistan. As expected, given the results of the correlation analysis reported in (Table. 2.1), South Asian countries with a low natural capital share realize a positive IW per capita growth (reported in the last column of Table 2.2), while countries such as India and Pakistan in the group of a high share of natural capital failed to realize positive growth rate of IW per capita. This shows that one of the other key factors that can result in declining wealth per capita, followed by population growth, is the high rate of natural capital depletion. Over the long run, these high

depletion rates, if not reinvested properly in other forms of capital, are bound to damage the trajectory of the sustainability criterion proposed by advocates of weak sustainability(Managi, 2018). However, this result does not hold in the case of Maldives despite its low share of natural capital. The reason for this might be the highest GDP per capita of Maldives among South Asian countries. The result is consistent with the correlation analysis that shows a strong positive association between GDP per capita and IW per capita growth.

To have a better understanding of the individual contribution of the capital assets in the increase (decrease) of the total wealth index between 1990 and 2014, the following tables break down the average contribution of each capital asset in relation to the total wealth.

Table 2.3: Value of Natural capital (Natural capital in billions of constant 2005 US$

	1990	1995	2000	2005	2010	2014
Bangladesh	62	58	56	54	54	51
Afghanistan	12	12	12	12	12	12
India	3,605	3,552	3,489	3,426	3,344	3,242
Pakistan	1,448	1,302	1,156	1,006	859	747
Nepal	222	202	182	170	170	170
Maldives	3	3	3	3		2
Sri Lanka	79	73	68	62	59	63

Source: UNU-IHDP and UNEP (2018)

Table 2.3 shows the share of natural capital for the selected region. It is interesting to note that the share of natural capital has declined in all seven selected countries over the period of twenty-five years. Despite the common belief that developing economies are endowed with a large share of natural capital, the table tells us that Maldives has the lowest share of natural capital. Still, Maldives was able to

fulfill the sustainability criterion by achieving positive, inclusive growth without depleting natural capital (as she is poorly endowed).

For countries like Pakistan and India that are already on an unsustainable trajectory, such a large rate of natural capital depletion is worrisome and is bound to put countries in much worse scenarios when gauged from the perspective of weak sustainability. In these countries, the decline in natural capital is another key factor, along with high population growth, that explains the negative per capita wealth trend.

Table 2.4: Human capital (Human capital in billions of constant 2005 US$

	1990	1995	2000	2005	2010	2014
Bangladesh	9,128	10,212	11,285	12,243	13,128	13,778
Afghanistan	139	200	248	316	382	451
India	315,760	336,737	370,475	402,271	433,257	457,110
Pakistan	1,033	1,207	1,397	1,603	1,853	2,087
Nepal	2,642	3,083	3,448	3,751	3,998	4,266
Maldives	5	7	8	9	11	12
Sri Lanka	292	331	369	385	392	449

Source: UNU-IHDP and UNEP (2018)

Table 2.4 gives the value of human capital of South Asian countries. All the countries experienced positive growth in human capital. In the case of Bangladesh, positive wealth per capita is mostly driven by a positive growth rate of human capital. On the other hand, India's growth in human capital (although positive) was not good enough to compensate for the combined effect of natural capital depletion and a high population growth rate.

Table 2.5: Produced capital (Produced capital in billions of constant 2005 US$

	1990	1995	2000	2005	2010	2014
Bangladesh	53	66	91	130	190	259
Afghanistan	25	25	24	24	28	31
India	867	1,141	1,557	2,241	3,618	5,049
Pakistan	157	196	231	265	315	339
Nepal	9	12	16	20	26	31
Maldives	1	1	1	2	4	5
Sri Lanka	35	42	52	64	86	113

Source: UNU-IHDP and UNEP (2018).

2.8 Framework for Mesuring Strong Sustainability

It is hypothesized in the literature that weak sustainability is a prerequisite for meeting the criteria of strong sustainability(Neumayer, 2003). Countries fulfilling the weak sustainability criteria have a bright chance of meeting the conditions of strong sustainability as well (ibid).

The next section tests the hypothesis that a country is on the trajectory of strong sustainability if its ecological footprint does not surpass its bio-capacity; then that country will be regarded as weakly sustainable if a country's ecological footprint exceeds its bio-capacity, but its inclusive wealth per capita has a positive trend. Otherwise, it will be deemed unsustainable because the de-accumulation of assets is greater than the accumulation of capital assets, and hence the productive capacity shrinks, and so does the opportunities to sustain well-being level. In order to test this hypothesis for the selected countries, the present study takes Ecological foot print per capita as an indicator of strong sustainability.

2.8.1 Strong Sustainability/Ecological Footprint

As discussed earlier, sustainability is defined as a non-declining level of well-being in its indicator over time ((David W Pearce & Turner, 1990; J. Pezzey, 1989). Both approaches accept this definition of sustainability and its general implication as a non-declining welfare level for future people. The point of divergence is with respect to the conditions required to achieve sustainability. Weak sustainability requires total wealth per capita to be non-declining. In contrast, strong sustainability requires the conservation of critical natural capital along with a constraint of non-decline in the overall capital stock for achieving sustainability.

Ecological Footprint is already discussed in detail, with its strengths and weaknesses. Here, in order to build the connectivity, some important aspects are highlighted again before discussing the empirical results.

Ecological Footprint is a physical measure of strong sustainability. Its objective is to measure the environmental impacts of human economic activity into the total land area of ecosystems required to supply the resources a human population consumes and to absorb the associated waste, both locally and elsewhere (Rees, Wackernagel, & Testemale, 1996) subject to the production practices in any given year (Wackernagel, et al., 2002). One distinguishing feature of this indicator is its focus on the 'consumption perspective,' and the consumer is deemed responsible for creating the ecological footprint; hence required land area is ascribed to the consumer rather than the producer. Taking into the spirit of SS, the unit of accounting used in the ecological footprint is land rather than money. It compares the existing bioproductive land area necessary to support the *consumption* activities for a given population. If the ecological footprint is higher than the existing bioproductive land area, then it implies that more land is required than actually exists to support the rate at which humans are consuming resources, and the current economic activity is not sustainable. The positive foot print is known as ecological deficit and indicates exceeding carrying capacity of the land area either due to the depletion of the country's natural capital or that country's consumption creates an ecological footprint on other countries via import.

2.8.2 Results and Discussions

The ecological footprint of the individual country (domestic demand), along with the biocapacity, is given in the following tables.

Table 2.6: Average Bio Capacity per person

	Afghanistan	Bangladesh	India	Nepal	Pakistan	Sri Lanka
1990	0.840	0.371	0.455	0.602	0.4628	0.501
1995	0.726	0.348	0.452	0.548	0.448	0.465
2000	0.605	0.355	0.450	0.539	0.449	0.463
2005	0.534	0.360	0.415	0.551	0.421	0.448
2010	0.518	0.380	0.428	0.541	0.415	0.467
2015	0.469	0.401	0.443	0.5784	0.380	0.487

Source: Global Footprint Network database

Table 2.7: Average Ecological Footprint per person

	Afghanistan	**Bangladesh**	**India**	**Nepal**	**Pakistan**	**Sri Lanka**
1990	0.816	0.488	0.783	0.828	0.759	0.852
1995	0.686	0.473	0.810	0.817	0.775	1.018
2000	0.683	0.531	0.858	0.834	0.832	1.186
2005	0.650	0.579	0.859	0.881	0.823	1.196
2010	0.703	0.675	0.995	0.877	0.891	1.254
2015	0.756	0.792	1.1304	0.993	0.809	1.448

Source: Global Footprint Network database

Table 2.6 illustrates the pattern of Ecological footprint from 1990-2015 for the selected region. The Ecological footprint per capita is on the rise for all the selected South Asian countries,indicating growing domestic demand and a growing population. In 1990, the average demand per capita of the region was 4.53 global hectares(gha),while in 2015, the average demand rose to5.93 gha, showing an increase of almost 47 percent (by a factor of 1.4 gha). During the same period, percapita bio capacity decreased by almost 24 percent (3.23 to2.76 gha per capita), as shown in Table 4.The underlying drivers of the increase in the Ecological Footprint are complex; however, the literature highlights two important determinants that can possibly explain the change: human population and per capita consumption(Lin, et al., 2018).

The difference of change in Ecological foot print and bio capacity per person quantifies the gap between human demands on biological capacity. Table 6 provides an overview of the ecological deficit/reserve situation for the selected region.

Table 2.8: Ecological Deficit/Reserves

	Afghanistan	**Bangladesh**	**India**	**Nepal**	**Pakistan**	**Sri Lanka**
1990	0.0246	-0.117	-0.327	-0.226	-0.296	-0.351
1995	0.040	-0.125	-0.358	-0.269	-0.326	-0.553
2000	-0.078	-0.176	-0.408	-0.294	-0.383	-0.723
2005	-0.116	-0.218	-0.444	-0.329	-0.401	-0.747
2010	-0.185	-0.294	-0.567	-0.336	-0.476	-0.786
2015	-0.286	-0.391	-0.686	-0.414	-0.428	-0.960

Source: Global Footprint Network database and Author's own calculation

This gap is negative, indicating that an increase in human demand has been outpacing the bio-capacity increase of the region. Throughout the selected period, the

average per-person ecological footprint of all the countries was higher than their average per capita biocapacity, thus an indication of a significant ecological deficit. This is a clear situation of "overshoot."South Asian region following a trajectory of un-sustainability from the strong sustainability perspective.

2.9 Conclusion

The purpose of this research was to investigate the countries' overall sustainability by using indicators of weak and strong sustainability, with a focus on developing countries in the South Asian region. The study also finds out the critical factors that could lead countries on the trajectory of sustainable development from the perspective of weak sustainability indicators.Results of the study indicate that countries such as Pakistan and India,with the highest share of natural capital in their total wealth, failed to satisfy the criterion of weak sustainability. Other countries in the group, such as Bangladesh, Nepal, and Sri Lanka, manage to have a sustainable path, primarily by growing their human and produced capital in compensation for the rundown of their natural capital stock. These countries follow a modest sustainable trajectory under a weak sustainability criterion. The study finds the share of natural capital as an important determining factor in South Asian countries; all countries with a low share of natural capital (such as Afghanistan, Bangladesh, Nepal, and Sri Lanka) achieved positive IW per capita, while countries with a high natural capital share (such as India and Pakistan) experienced a negative growth rate of inclusive wealth per capita. The only exception is Maldives which achieved a positive IW per capita despite having a high natural capital share. Maldives has the highest GDP per capita among all South Asian countries, which indicates that the higher the GDP per capita a country has, the easier it is for that country to achieve a sustainable path.

This result suggests that even a country with a high level of natural capital share can satisfy a weak sustainability criterion or, in other words, achieve positive IW per capita growth in the long term if the country successfully increases Physical Capital at a level high enough to compensate for the decline in natural capital.

For this reason and given that the trend towards high natural capital consumption continues, developing countries might be recommended to carefully maneuver economic growth through the effective conversion of their Natural Capital

to Physical Capital and establishing related policies to achieve sustainable development. From the stong sustainability perspective, throughout the selected period, the average per-person ecological footprint of all the countries was higher than their average per capita biocapacity, thus an indication of a significant ecological deficit. This is a clear situation of "overshoot."South Asian region follows a trajectory of un-sustainability from the strong sustainability perspective. The overall result is not satisfactory for the region if compared from the lens of both weak and strong sustainability criteria. Despite the fact that all of the countries in the South Asian region showed positive GDP growth rates and promising performance in the Human Development Index, the overall region is showing unsatisfactory performance from the criterion of sustainability. This finding highlights the need to improve and include sustainability indicators in the policy discourse.The conventional performance indicators fail to tackle sustainability issues.

3. THE IMPACT OF INCOME INEQUALITY ON CARBON EMISSIONS: A CASE STUDY OF SELECTED DEVELOPING COUNTRIES

3.1 Introduction

The current period has seen an increase in the social and environmental crisis globally. The social crisis is characterized by an increase in income inequality which has been on the rise since the 1980s around the world, with levels approximately equal to those witnessed in the United States at the beginning of the 20th century (OECD, 2014).On the one hand, the sharp rise in income inequality across the globe not only undermines economic growth but also gives rise to a plethora of problems, such as poverty (Persson and Guido, 1994; Piketty and Goldhammer, 2014; Hübler, 2017), harm social order (Wilkinson and Pickett, 2009), increased health risks (Kaplan et al., 1996; Lynch et al., 2000; Wilkinson, 2002) high risk of political instability (Alesina and Perotti, 1996; Acemoglu and Robinson 2005). These problems, in turn, threaten the social and economic sustainability of mankind and adversely affect human well-being[28].

On the other hand, the environmental crisis has been manifested in increasing environmental pressures since the 1950s, which has resulted in climatic disturbances and notable widespread changes in the ecosystem (IPCC, 2014; Millenium Ecosystem Assessment, 2005). These environmental problems give rise to a host of problems that threaten the existence of human beings/human sustainability, like food insecurity, loss of livelihoods, loss of infrastructure, worse health outcomes, and violent conflicts (for details, see, e.g., Rosenzweig et al. 2001; Reuveny, 2007; McGranahan et al., 2007; Buhaug et al., 2010; Watts et al. 2018). Given this premise, understanding the link between income inequality and carbon emissions is of paramount importance to enhance our understanding of these challenges. The global community is acutely aware of these challenges, and their importance is reflected by their inclusion in the Sustainable Development Goals (SDGs). To address/combat the dual problems of

[28]The historical events of recent times such as Brexit, Sino-US trade warand the Occupy Wall Street Movement are all linked to income inequality within and across countries (Wan et al., 2022).

inequality and climate change, many steps have been taken place including the Paris Climate Agreement, which was signed and ratified by 190 countries of the world. Though some progress has been shown in the last few decades to alleviate income inequality, nevertheless, income inequality is still high in most developing countries around the globe. According to the latest findings of the World Bank (2020), ecological disruption will push more than 68 million people into poverty by 2030. People living in Asia and Africa, in particular, are more vulnerable to the effects of global warming because the world's impoverished are concentrated in these regions. However, finding ways to reduce income inequality coupled with environmental preservation is a complex and difficult/uphill task for both developed and developing countries. One of the conceivable solutions has been to adopt growth-oriented policies, as it is commonly believed that growth leads to poverty reduction, particularly if it does not increase income inequality (Bourguignon, 2003). However, growth-oriented policies increase income inequality and exert pressure on ecological resources, thus making the relationship more complex and challenging. Tackling the rising inequality and deteriorating environment is like ''killing two birds with one stone'' (Masron, 2019). Therefore, untangling the inequality-environment nexus has important implications for environmental economists and development practitioners who want to solve the twin issues of reduction in income inequality and improving the environment to ensure a sustainable outlook.

A large body of literature has explored the possible links between economic growth and carbon emission (the largest contributor to greenhouse gas emissions and, consequently, rising global surface temperatures). The literature suggests that economic growth aggravates greenhouse gases emission up to a certain level of economic development and then decreases (IPCC, 2014). This idea is known as the environmental Kuznets curve hypothesis (EKC), which remains the most dominant framework for analyzing the impact of economic development on environmental deterioration up until the 1990s. The EKC hypothesis, in line with the neoclassical paradigm, postulates that the relationship between economic growth and polluting emissions follows an inverted U-shape (Grossman and Krueger, 1995), thereby arguing that the respect of ecological constraints with economic growth is achievable in the long run. Initial empirical studies examining the EKC mostly rely on simple

reduced-form models in which environmental quality is measured as a function of only income (e.g., World Bank, 1992; Grossman and Krueger, 1991; Selden and Song, 1994). Recent research, however, shows concern about the omission of explanatory variables in earlier studies and argues that other factors could be important determinants of environmental outcomes (Kim and Baek, 2011). Economists have noted relative income (income inequality) as one of the potential omitted variables in the environment-income relationship. The early studies that explored the effect of inequality on environment-income relations include (Scruggs, 1998; Torras and Boyce, 1998; Marsiliani and Renström, 2000; and Ravallion et al., 2000). As we discuss below, the theoretical and empirical literature on the inequality-environment nexus remains inconclusive, pointing to competing mechanisms and effects[29].

The available theoretical literature on income inequality and the environment nexus offers two competing mechanisms. First, the political economy approach of Boyce (1994) and Torras and Boyce (1998) suggests that income inequality affects environmental quality indirectly via the distribution of political power. The inequitable distribution of income gives rise to unequal allocation of political power concentrated among a few citizens (rich), allowing them to influence policymaking in their favor. Second, the economic mechanism (or consumption channel),developed by Ravallion et al. (2000) and Heerink et al. (2001), is primarily based on the difference in the propensity to emit across the different economic spectrums. The basic premise isthat a reduction in income inequality (transfer of money from rich to poor) will increase the emission level if people at the lower end of the economic strata have a lot higher propensity to emit relative to people in the uppereconomic strata. Conversely, if people at the upper end of economic distribution have a lower propensity to emit due to more efficient use of resources, then higher inequality can reduce aggregate CO_2 emissions.Hence, the relationship between income inequality and carbon emission is an empirical question.The extant empirical literature on the link between income inequality and environmental quality provides conflicting results. One dominant group of the literature has shown that inequality negatively affects the environment, for instance (Baek and Gweisah, 2013; Zhang and Zhao, 2014; Hao et al., 2016; Kasuga and Takaya, 2017; Jorgenson et al., 2017; Uzar and Eyuboglu, 2019; Padhan et al.,

[29] For a detailed review on theoretical and empirical literature, see, Berthe and Elie (2015).

2019; and Baloch et al., 2020). On the contrary, others find a negative association between income inequality and carbon emissions. This implies that there exists a trade-off between environmental preservation and social justice. (see, e.g., Ravallion et al., 2000; Heerink et al., 2001; Borghesi, 2006;Qu and Zhang, 2011; Grunewald et al., 2017; Guo, 2014; Belaïd et al.,2020; Hailemariam et al., 2020; Rojas and Lastuka, 2020; Langnel et al., 2021).

Despite a considerable amount of studies investigating the relationship between inequality-environment nexus, the results remain inconclusive. One of the major issues is the focus of the existing studies on the static relationship between inequality and environmental degradation. Since these two variables are likely to have some unobserved common causes, using simple cross-sectional regression might yield a biased and inconsistent estimate, thereby casting doubts on the reliability of empirical results (Hailemariam et al., 2020). Moreover, most of the empirical studies have applied econometric methods such as Ordinary Least Squares and fixed-effect models that fail to address the problems of cross-sectional dependence and endogeneity[30]. To the best of our knowledge, the empirical studies that are related to our work include Hao et al. (2016), which address the issues of endogeneity and heterogeneity by employing first difference GMM for the Chinese eastern and western regions. Hailemariam et al. (2020) accounts for potential heterogeneity and endogeneity by employing the common correlated effects mean group estimator (CCEMG) for OECD countries, and Grunewald et al. (2017) uses the group fixed effects estimator to address the unobserved heterogeneity. Our study complements these studies by employing the modern econometric technique of system GMM that accounts for unobserved heterogeneity, potential endogeneity, and autocorrelation.

The focus of the study is on the developing world (both lower-middle-income and upper-middle-income countries) because of the urgent need to tackle up twin challenges of income inequality and CO_2 emission in the developing region. Given the economic dynamics of the countries, there is significant evidence of environmental deterioration accompanied by growth (Grossman & Krueger, 1995), and the situation is more alarming in the developing world as these countries are mostly in the early or

[30]Since income inequality is a persistent variable, it requires specifications accounting for the dynamic settings (Hailemariam et al., 2020).

middle stages of their development, and tend to pollute the environment more due to potential contribution of the environment in the process of their economic growth (Masron and Subramaniam, 2018). On the other hand, rapid growth in developing countries also brought about social challenges, such as the widening of income inequality (Hao et al., 2016). The worsening of income inequality indicators in developing countries evokes serious concern as the poor in these countries are dependent on the environment to assist their basic needs, thereby leading to a deterioration in the environment (Grossman and Krueger, 1995). Moreover, the poorest in impoverished countries are more vulnerable and less resilient to counter the negative impacts of environmental changes (Stern, 2007; Awodumi and Adewuyi, 2020). These situations may undermine environmental sustainability (Wu and Xie, 2020).

Given the above premises, the present study aims to analyze the following three questions. (i) What is the impact of inequality on the carbon dioxide emissions of developing countries? (ii) Does this effect depend on the level of income and vary across the whole (global) sample and sub-samples (upper-middle income and low and lower-middle-income countries? (iii) Does a political channel of inequality-environment nexus exist in the selected sample?

In this respect, the contribution of the present study is manifold. (i) Unlike previous studies, which ignored the econometric issues, this study uses the system generalized method of moments (GMM) methodology in a dynamic framework to address the issues of unobserved individual country-oriented effects and potential endogeneity. (ii) This study explores the possible political channel that could affect the relationship between inequality and carbon emission along with economic mechanisms, thus presenting a more comprehensive view. (iii) This study provides a global perspective for the developing countries around all continents, along with evidence in a comparative setting for the upper-middle-income and low- and lower-middle-income countries.

The remainder of the study is designed as follows: The second section of this study provides a theoretical framework of the inequality-environment nexus and reviews the empirical studies. The third section describes the data and methodology.

The fourth one discusses the empirical findings, and the last and fifth section concludes the study.

3.2 Literature Review

3.2.1 The role of Inequality on Environmental Degradation: A Conceptual Framework

The purpose of this section is to summarize and compare the existing theoretical literature linking the role of income imbalance on environmental quality. Broadly speaking, the theoretical literature relating to inequality and environmental pressure can be structured in two channels: the first relates to environmental degradation due to individuals' economic behavior, and the second is based on the implementation of environmental policies aimed at addressing environmental pressures. In line with neoclassical economics, the EKC hypothesis is the most widely used argument which links the relation between environment and growth. The shape of this curve depends upon public regulation, and growth alone is not a substitute for environmental policy (Grossman and Krueger, 1996). Therefore, improvements in the environment are arbitrated by the induced policy response, which plays the role of a mediator between per capita income and pollution. To achieve the objective, public policies come into play through the mobilization of different regulating tools such as taxes, norms, or ad hoc markets.

However, conflicting interests exist in the use of the environment among different actors. Public regulation requires stabilizing the collective and individual behaviors to develop the required conventions for pursuing the goal of sustainable development. It is important to note that polluting activities do not affect every stakeholder in the same way and result in winners and losers. For example, the interest of capital holders is to pursue production activities at a minimum cost or, in simple words, to externalize the social costs of their pollution-generating actions. More often than not, the winners are the capital holders, and the victims are the users of the degraded environment. Therefore the power inequalities between these groups make them face the harm of pollution differently. Boyce (1994) was one of the first to formalize the link between the effects of power inequalities on environmental quality

and set forth his argument on the political-economy approach.[31] He supports the hypothesis that greater inequality may be the potential cause of environmental deterioration.

In the neoclassical paradigm, there exist two ideal situations; the Laissez fair and Coase criterion of social optimality. In the former, the capital holders (winners) pursue their polluting activities by ignoring the costs borne by the victims (losers) until their marginal benefit becomes zero. At this point, the level of pollution touches the maximum. If the increasing marginal cost faced by the losers is to be internalized by the winners, then the latter criterion of social optimality is achieved, where marginal benefits equal the costs of the losers. Nonetheless, the presence of transaction costs in such trade-offs causes the actual resultant to lie between these two situations.

Boyce, however, argues that the wealth and political inequalities among winners and losers, as measured by their ability to endure transaction costs, lead to a compromise that is incompatible with the socially optimal outcome.

According to Boyce, in an unequal society, the affluent are likely to have more political power that can put them in a better position to influence the decision-making process on projects having ecological impacts and safeguard their interest. Such decisions are based totally on the competition between those who benefit from the ecologically damaging projects and those who endure the costs of it. Boyce (1994) argues that the wealthy benefit disproportionately and are generally the winners, whereas the poor segment faces the brunt (e.g., pollution, proximity to industrial activities) of environmentally degrading actions. Boyce (1994) defined this situation as a power-weighted social decision rule (PWSDR), where the greater disparity in the distribution of political power leads to increased environmental degradation/emissions as the political realm protects the interests of the affluent.

In addition, Boyce (1994) puts another possibility in which a highly unequal society impacts the rate of environmental time preference for both poor and rich

[31]The political-economic approach is based on a power-weighted social decision rule, in which the power imbalance between the wealthy and the poor allows the wealthy to reap more benefits and suffer less harm from environmental degrading actions, as beneficiaries being in a better policy position to protect their interests.

segments. It affects the consumption pattern of the poor segment of society due to their short-termism, and they tend to overexploit natural capital and do not have the luxury to take into consideration the long-term impact of their consumption choices and mainly focus on fulfilling their short-term material needs. On the other hand, wealthy people might fear the risk of revolts and political upheaval, which may put an end to their privileges and hence also be more short-term oriented. Their fear induces them to prefer the present more and indulge in production activities to maximize their current results without taking into consideration the harmful effects of their activities on the environment. Therefore, for Boyce, an increase in inequality induces both rich and poor to degrade their environment more.

Thus, Boyce (1994) concluded that inequality hurts the environment, and more egalitarian income distribution can enable the relatively powerless to raise their voice more effectively in the political process. Moreover, a decrease in income inequality creates an environmental consciousness which increases the demand for environmental quality (Magani, 2000).

Boyce's view was contested by Scruggs (1998), who developed explanations to defend the opposite view. He argued that equality and democracy may or may not be the plausible solution to minimize environmental degradation, as proposed by Boyce. He rather claimed that under certain conditions, higher inequality might even be conducive to environmental protection. Scruggs (1998) put forth three different situations to explain the impact of variation in income inequality on environmental degradation. By applying the method of methodological individualism, Scruggs showed how the relationship between income distribution and environmental quality depends on the relation between individual income level and environmental pressures. Figure 3.1 shows three different hypotheses regarding the direction of the marginal variation in environmental degradation.

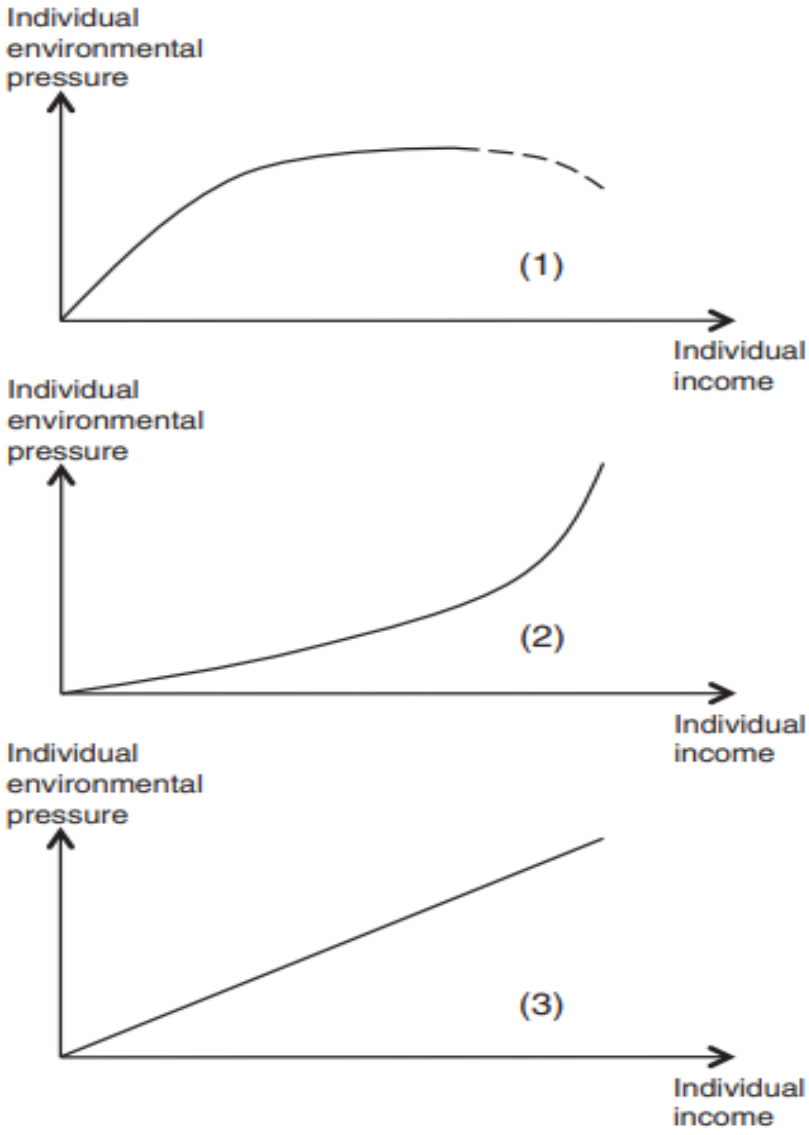


Figure 3.1: Marginal variation in environmental degradation

In situation 1, the relationship between income and pollution is concave, with marginal environmental pressure decreasing for each individual, indicating a marginal decrease in the environmental pressure. In this case, the utilization of an additional income by a poor person will emit more environmental pressure than the utilization of the same unit by a wealthy person. Therefore, the affluent persons having additional income at their disposal would, on average, result in less deprivation of the environment than a benchmark society might do. In short, situation 1 depicts a negative relationship between inequality and environmental degradation.

On the contrary, in situation 2, the income-pollution relationship is convex, indicating a marginal increase in the environmental pressure. In this case, the movement of income from higher groups to smaller groups will reduce environmental pollution, or, in other words,a reduction in inequality suits the environment. Lastly, Situation 3 shows a linear trend, where environmental degradation remains unaffected by income redistribution.

Scruggs (1998) and Heerink et al. (2001) considered Situation 1 as the true representative of reality and based their notion on the assumption that the quality of the environment is a luxury good, i.e., the demand for which increases at an increasing rate as income increases. Indeed, Scruggs (1998) uses the post-materialism theory that Inglehart (1990) first developed to explain the increased preferences of wealthy people for the environment. The idea is that actors tend to prefer post-materialistic values such as environmentalism once their short-term material needs are satisfied. Thereby, he also concludes that more affluent people also demand environmental protection as opposed to Boyce's (1994) conclusion of affluent people using their position to influence self-interested policies.

Additionally, in explaining the first curve, Heerink et al. (2001) argued that affluent households are in a better position to substitute environmentally damaging goods with less polluting goods. In this way, Heerink et al. (2001) utilize this hypothesis to draw/support the idea of the environmental Kuznets curve at the level of an individual household by supplementing the first curve with a decreasing segment (shown with the dotted line in Figure 1) beyond a certain threshold level of income. In short, the idea is that wealthy households exert less individual environmental pressures and that the relationship between inequality and environmental deterioration cannot be one-to-one, as claimed by Boyce (1994).

Furthermore, some other arguments relativize the reality of Situation 1 and highlight the harmful impact that a progressive redistribution of wealth could have on the environment. The first way to explain the situation is to take into account the idea of decreasing the marginal propensity to consume with the increase in income.[32] After

[32]As the total effect of consumption on the environment depends not only on the content but also on the magnitude of that consumption

all, even if the consumption choices of the poor and rich are identical in terms of environmental pressure, the fact that rich actor saves more proportion of their income may infer that their per unit environmental cost is less. Additionally, the goods choices of middle-class households may be of poorer quality and may be more polluting.

Another argument that supports the positive impact of inequalities on environmental quality is the provision of outlets for innovations. Since innovative outputs are expensive when emerging and require a sizeable market to fulfill their effective demand, wealthy households will be the key player in the development of such a market segment.

However, this positive association between income and post-materialistic values[33] /environmental protection does not guarantee/necessarily bring changes in consumption behavior. For example, according to Fleurbaey et al. (2014), the predictive power of values related to environmentally concerned consumer behavior is low (approximately 20%), leading to an increase in greenhouse gas (GHG) emissions.

This value–action gap can be explained by a range of factors, such as misinformation on the consumer part about the adverse impact of their action on the environment (Custora, 2012). Another explanation includes the competition between environmental concerns with other concerns, such as the desire and ability of the richer people to achieve a higher standard of living by ignoring the ecological impacts of their consumption behavior. Additionally, Roca (2003) identified that affluent people could continue their environmentally damaging practices without bearing the consequences as their power and position put them in a place to displace the costs to others.

The above debate indicates the complexity that lies between the environment and inequality relation. This complexity is due to the conflict between the underlying mechanisms. On the one hand, some arguments shed light on the harmful impact that a reduction of inequality could have on the environment. On the other hand, some discuss the positive impact of inequality on environmental protection

[33] Post-materialism refers to the idea of increasing ecological conscious in the behavior of consumers with the increase in income.

3.2.2 Empirical Findings

The relationship between the environment and inequalities has been the subject of a substantial amount of empirical investigation since the late 1990s, which has yielded a plethora of findings. Different indicators of the environment, such as carbon dioxide (CO_2) emissions, nitrogen oxide, sulfur dioxide, water and soil pollution, and biodiversity, have been used for this purpose. The measure of the Gini coefficient is used as an indicator of income distribution in most of the studies due to either unavailability of a wide range of inequality measures or difficulties in obtaining data. The scope of the studies also differ depending on the availability of data; some studies concentrated on specific country analyses, while others focused on regional analyzes. Based on the results, this study classifies the literature into three subcategories. The first strand of the literature concluded that inequality negatively affects the environment, while the studies placed in the second category concluded the opposite results. The last group of studies remained indeterminate.

In one of the earlier attempts, Torras and Boyce (1998) examined how inequalities interact with per capita income to explain pollution. More specifically, the study strives to test the hypothesis that the effect of inequality on pollution differs between low- and high-income countries. They calculated the equation that connects pollution levels to per capita GDP and bargaining power. The latter is approximated by the Gini index, the literacy rate, and an indicator of civil and political rights. In the first instance, they estimated the regressions without taking into account the inequality variables. Their findings are consistent with Grossman and Krueger (1995) and corroborate the EKC for the majority of contaminants. Second, by including inequality factors, they found that the statistical significance of per capita GDP effects diminished. The study observes that an increase in the literacy rates of low-income countries tends to reduce pollution levels globally. A similar pattern was detected for the index of political rights. The Gini index has varying effects depending on the pollutant under consideration. Greater income inequality is associated with increased pollution in low-income nations for S02 and smoking. In the poorest countries, rising inequality affects the percentage of the population with access to safe drinking water. In other words, when per capita GDP is low, there is a greater likelihood that inequality

will hurt the quality of the environment. Similar conclusions were drawn by Shafik and Bandyopadhyay (1992) and Selden and Song (1994).

In another study, Magani (2000) also put the political economy theory to the test by taking public spending on research and development for environmental protection rather than pollution level. The study supported the positive association between inequality and environmental degradation and concluded that reductions in pollution are more likely to occur if a country's economic growth is followed by improvements in socioeconomic equality within the country. Koop and Tole (2001) also concluded that inequalities in income and land ownership tend to exacerbate deforestation in tropical countries. The studies of Mikkelson et al. (2007) and Holland et al. (2009) used biodiversity indicators to examine their link with inequality. Studies found income inequality to be a statistically significant predictor of biodiversity loss and that reduction in income equality prevents biodiversity loss. In the case study of China, Golley and Meng (2012) used 2005 household data to analyze the relationship between income distribution and CO_2 emissions. The findings indicate that urban CO_2 emissions could be reduced by redistributive policies that alleviate income disparity.

For the USA case, Baek and Gweisah (2013) provided a piece of evidence favoring the negative impact of income inequality on CO_2 emissions. Their study used data for the period 1967-2008, and both short and long-run analyses found a positive nexus between income distribution and CO_2 emissions. Zhang and Zhao (2014) address this question for several regions of China between 1995 and 2010 and found a positive link between deterioration in income distribution and environmental degradation. A similar conclusion was drawn in the Hao et al. (2016) study, which was also conducted in 23 provinces of China. This study tried to find the impact of income inequality on economic growth and the influence on CO_2 emissions in the process. EKC hypothesis was found to exist, and inequality was found to aggravate environmental pollution. Knight et al. (2017) examined the linkages between income inequality and CO_2 emissions in 26 developed countries from 2000 to 2010. According to the findings, rising income inequality worsens environmental degradation by increasing economic and political power disparities.

In another study conducted for the BRICS countries, Zhu et al. (2018) concluded that in medium and high-emission countries, there is a significant and positive relationship between income inequality and CO_2 emissions. Masud et al. (2018) tested the impact of income inequality on the environmental sustainability of the Association of Southeast Asian Nations (ASEAN) for the period 1985-2015. This study uses different indicators of environmental sustainability along with the Gini coefficient as a measure of income inequality. The empirical findings confirm the detrimental effects of increasing inequality on environmental sustainability and indicate the role of government in reducing income inequality to improve the environment. Morse (2018) examined the relationships between income, environmental degradation, and income inequality from 1995 to 2014. The study concluded that a reduction in income disparity and an increase in income level might solve environmental problems. In another country-level study, Uzar and Eyuboglu (2019) found evidence of a positive association between the income gap and emissions per capita. Liu et al. (2019) found a positive relationship between emissions and the income share held by the top 10% in the short run, while the long-run relationship turned out to be the opposite.

On the contrary, some studies found a positive stimulus of income inequality on environmental quality. For instance, studies by Ravallion et al. (2000) and Heerink et al. (2001) found evidence of a negative association between economic inequality and carbon emissions, implying that there exists a trade-off between social justice and environmental conservation.

Brannlund and Ghalwash (2008) used Swedish household budget surveys conducted in 1984, 1988, and 1996 to investigate inequality and the environment and found an improvement in the CO_2, SO_2, and nitrogen emissions with a deterioration in income distribution. In another regional study, Coondoo and Dinda (2008) found a similar pattern for Europe and North America, where a reduction in inequality increased the level of emissions while the result was insignificant when all countries were taken together, which points out the presence of heterogeneity across countries. Jun et al. (2011) investigated the relationship between income inequality and the number of environmental quality measures for Chinese provinces over the period 1996-2008. The study used industrial wastewater and gas emissions as dependent

variables and found that income equality is favorable for the environment. The existence of a similar trade-off between income inequality and water pollution was confirmed by Gassebner et al. (2011) through research conducted for 120 countries. Grunewald et al. (2017) also tested the inequality-CO_2 emissions nexus and found a negative nexus between the two in the case of developing countries, while the trade-off was not confirmed in the case of upper and middle-income countries. The study pointed out the negative impact of government redistributive policies on environmental degradation.

Unlike the first two groups, the studies placed in the third group remained indeterminate about the impact of inequality on the environment.

Scruggs (1998) investigates the equality hypothesis, which holds that a reduction in inequities leads to an improvement in the environment. For Scruggs' calculations, he uses data on water quality (dissolved oxygen), air quality (SO2 and particle concentrations), and industrial democracies, from which he constructs a composite indicator of emissions. As a result of the findings, it appears that the impact of inequality on ecological deterioration is indeterminate. Only the indicators of dissolved oxygen and particles are shown to be strongly linked with the Gini index in the first set of regressions.

The expected sign is also only observed with the first indicator, which is a further limitation. The results of the second set are equally unclear because the Gini index is not significant (except for one particular regression), but the sign of the index is pointing towards a beneficial impact of inequalities on the environment. The expected sign is also only observed with the first indicator. The results of the second set are equally unclear because the Gini index is not significant (except for one particular regression), but the sign of the index is pointing towards a positive impact of inequalities on the environment. Clement and Meunie (2010) analyzed the nexus between income distribution and environmental quality indicators in 83 transition economies for the period 1988-2003. The study found no significant relationship between the Gini coefficient and S02 emissions, while water pollution was found to be negatively affected by the increase in income inequality. In another study conducted for 47 transition economies, Olicardo (2016) found no significant relationship between

the Gini coefficient and CO_2 emissions. The environment-inequality nexus was investigated for India and China by Wolde-Rufael and Idowu (2017). Their study used CO_2 emission as a dependent variable with the Gini coefficient, GDP per capita, commercial openness, and per capita energy consumption as explanatory variables. This study failed to find the statistical significance of inequality in environmental degradation. A similar conclusion was drawn in a Jorgenson et al. (2017) study for the US; however, the study did find a positive link between the emissions and the income share held by the top 10%. In another study, Barra and Zotti (2018) investigated the EKC hypothesis by including inequality in the model. The study included 120 countries over the time span of 2000-2009. They found that EKC is not valid for the sample countries.

3.2.3 Conclusion

At this moment, similar to the theoretical debate, there is no agreement in the empirical research on the relationship between income distribution and environmental quality. The vast majority of studies remain inconclusive about the impact of inequality on the environment. In this context, the literature calls for a comprehensive analysis exploring the different mechanisms affecting the nexus and adopting a novel methodology to overcome the problems associated with the existing empirical literature.

3.3 Methodology

The purpose of this section is to explain the variables, data set, and sample details used to estimate our desired regression. This study uses panel data from 69 developing countries[34] around the globe-spanning from 1990 to 2020.

3.3.1 Theoretical Model

The most commonly used model to link the relationship between income and environment is the EKC hypothesis. EKC hypothesis posits the existence of a non-linear (an inverted U-shaped) relationship between income and environmental degradation, that is to say, that environmental pollution may initially increase with the

[34] The list of investigated countries is given in the appendix.

increase of per capita income. However, after reaching a certain level, environmental quality improves with the increase in income.

Following Ravallion et al. (2000), the current study augments the EKC hypothesis to document the relationship between income distribution and the environment.By incorporating inequality in the basic EKC model, the study also creates a link with the initial work of the Kuznets curve, which linked income inequality with a pattern of income level and found an inverted U-shaped relationship between the two (Kuznets, 1955).

The rationale for including the distribution of income along with average income is as follows:

The emission rate is related to the consumption of goods, either directly (due to the consumption of that good) or indirectly (via its production). Based on the EKC hypothesis, we postulate that individuals derived demand function for carbon emission depends on the level of income and is given by:

$$ER = f(Y_{ij}) \quad \textbf{(3.1)}$$

where ER = emission rate, Y_{ij} represents the income level, and $f(Y_{ij})$ is the derived demand function of individual i in country j. The marginal propensity to emit is given by:

$$MPE = f'(Y_{ij}) \quad \textbf{(3.2)}$$

The average emission rate of country j is the sum of the individual demand for emission and is given by:

$$ER_j = \frac{1}{M_j}\sum_{i=1}^{M_j} f(Y_{ij}) \quad \textbf{(3.3)}$$

The impact of relative income (income inequality) on the emission rate depends on the properties of the demand function f. the following cases are possible.

Case 1:

If an emission rate is an increasing function of average income and that MPE decreases with the rise in income ($f'(Y_{ij}) > 0 \; and \; f''(Y_{ij}) < 0$, then in such a case,

any effort of income redistribution to reduce inequality will increase the aggregate emissions. Therefore, by including the inequality in the above equation, we get

$$ER_j = f(Y_j, INQ_j) \text{ Where, } Y_j, > 0 \; and \; INQ_j < 0 \qquad \textbf{(3.4)}$$

The average level of emission rate is also affected by the share of manufacturing and urbanization in the country. Both of these are expected to affect the rate of emission positively. Including these two in the above equation yields

$$ER_j = f(Y_j, INQ_j, MAN_j, U_j) \qquad \textbf{(3.5)}$$

This case suggests a trade-off between controlling global warming and reducing inequality.

Case 2:

Again, if the derived demand for emissions increases with the rise in average income but now assumes that MPEincreases with the increase in income, then the results will be reversed. In this case, reducing inequality is favorable for controlling emissions.

To further explore the channel of political mechanism in the inequality and environment dynamics, the political rights variable is included in the analysis.

3.3.2 Definition and Constrution of Variables

- Carbond Dioxide Emission (CO_2)

The dependent variable is the CO_2 emission per capita which is calculated as the total emissions of CO_2 in metric tons per capita. Empirical studies have used different variables to capture the effect of environmental degradation, such as nitrogen oxide and sulphur dioxide (Torrce and Boyce, 1994;Brännlund and Ghalwash, 2008; Clement and Meunie, 2010; Heerink et al., 2001); and, to a lesser extent, another composite indicator of environmental degradation, such as ecological footprint (Dorsch and Kirkpatrick, 2014). This study uses CO_2 emission as an indicator of environmental degradation due to the following reasons. CO_2 emission is deemed as the single largest contributor to greenhouse gas emissions; almost 65% of the total greenhouse gas emission comes from CO_2, as per IPPC (intergovernmental panel on climate change).

- Inequality (Gini Coefficient)

The variable of interest is income inequality which has proxied with an index of the Gini coefficient in line with the existing literature. The data on the Gini coefficient is available from different sources such as World Bank, Standardized World Income Inequality Database (SWIID), All the Ginis (ATG), and the most widely used Deininger and Squire (1997) dataset. This study uses the SWIID data set of inequality developed by Solt (2009) for the following reasons; the coverage of this data set is greater than the other two sources, which enables us to carry out the analysis for the developing countries around the globe. SWIID data set provides information on the Gini coefficient based on net and gross income. Considering the fact that net income reflects the purchasing power of households and is, therefore, more relevant to our analysis. Therefore, this study uses data of the net income Gini coefficient for the regression analysis.

- GDP per Capita (GDP)

In addition to the variable of interest, several other control variables are also included to enter the regression based on the literature. To investigate the effect of a country's economic growth (average level of income) on CO_2 emissions, GDP per capita (constant 2010 US$) is included as the control variable. Based on the previous literature, this study uses the logarithmic form of GDP per capita (constant 2010 US$) and its quadratic component to test the environmental Kuznets relationship.

- Urbanization Rate (Urban)

Considering the existing literature, urbanization is considered another influential factor in CO_2 emissions studies (Xu and Lin, 2015; Li et al., 2015; Hao et al., 2016; Hashmi and Alam, 2019). This is because urbanization means more people living in the urban area and more economic activity, thus more agglomeration effects and high energy consumption of urban residents, hence more CO_2 emission. This study includes the urban population (% of the total population) as a control variable.

- Manufacturing, Value Added (% of GDP)

Another control variable is the share of the manufacturing sector in GDP. The rationale for including this variable is the more energy-intensive nature of this sector

(Wan et al., 2022), thus more CO_2 emissions, as concluded by ample studies (Grunewald et al., 2017; Aller et al., 2021; Wan et al., 2022).

- Political Rights (PR)

To test the political-economy hypothesis of Boyce (1994), this study uses the variable of the political rights index (PR) provided by the Freedom House (2015). PR measures the political freedom or power equality or bargaining power of different groups on a scale of 1(most free) and 7(not free).

3.3.3 Data and its Sources

The study used secondary data that has been taken from Secondary official sources. The main source is World Bank (World Development Indicator). Data on CO_2 emissions, GDP per capita, urbanization, and the share of the manufacturing sector to GDP have been taken from WDI.[35] Data on political rights have been taken from Freedom House (2015). The data on inequality is taken from Standardized World Income Inequality Database (SWIID). The following table provides an overview of the main and control variables used in the study, along with their summary statistics.

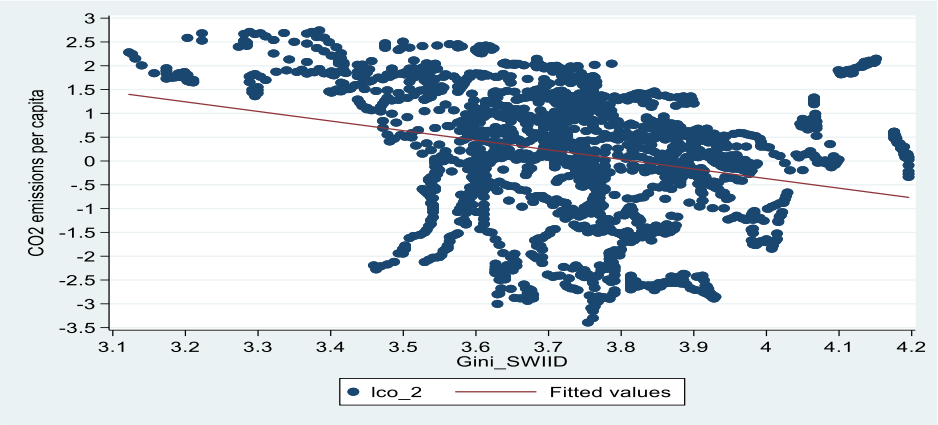
[35] data.worldbank.org/data-catalog/world-development-indicators/wdi-2012

Table 3.1: Descriptive Statistics

Source: WDI, SWIID, and Freedom house

	Variable	Obs	Mean	Std. Dev	Min	Max
Full sample	lco_2	2,000	.170751	1.31151	3.392801	2.744147
	Lginid	2,139	3.731212	.1846295	3.122365	4.195697
	Lgdp	2,127	7.769104	.8851774	5.374105	9.561016
	lgdpsq	2,127	61.14215	13.52753	28.881	91.41302
	lurban	2,139	3.775839	.4992159	1.689358	4.522995
	Lman	2,108	2.573919	.4905483	.4269712	4.610459
	PR	1,966	4.169247	1.859566	1	7
UMI countries	lco_2	961	1.008229	.7733315	-.8359054	2.744147
	lginid	961	3.729821	.2158946	3.122365	4.195697
	lgdp	956	8.481975	.4965778	6.701751	9.561016
	lgdpsq	956	72.19023	8.313457	44.91347	91.41302
	lurban	961	4.08288	.30088	3.122541	4.522995
	lman	930	2.66406	.4645158	1.402793	3.79424
	PR	819	3.299145	1.775172	1	7
LMI countries	lco_2	1,178	-.512455	1.263665	-3.392801	2.585536
	lginid	1,178	3.733229	.1542109	3.202746	4.09936
	lgdp	1,171	7.18712	.6842937	5.374105	8.633039
	lgdpsq	1,171	52.12255	9.744075	28.881	74.52937
	lurban	1,178	3.525358	.4889702	1.689358	4.329074
	Lman	1,178	2.502755	.4989762	.4269712	4.610459
	PR	1,147	4.772014	1.702965	1	7

Figure 1 represents the scatter plot of carbon dioxide emission and income inequality. The fitted line shows a negative relationship between the two.



Data Source: SWIID for Gini and WDI for CO_2

Figure 3.2: Scatter plot of Gini and CO2 emission

3.3.4 Sample Size and Sample Selection Method

To test the hypothesis "whether income inequality contributes to environmental degradation," the study used data set of sixty-nine selected countries around the globe (see Appendix). The analysis is confined to sixty-eight developing countries due to the following motives. First, the choice of countries is mostly dictated by the availability of data. The focus of the study is on the developing world (both lower-middle-income and upper-middle-income countries) because of the urgent need to tacklethe twin challenges of income inequality and CO_2 emission in the developing region. Given the economic dynamics of the countries, there is significant evidence of environmental deterioration accompanied by growth (Grossman & Krueger, 1995), and the situation is more alarming in the developing world as these countries are mostly in the early or middle stages of their development, and tend to pollute more environment due to potential contribution of the environment in the process of their economic growth (Masron and Subramaniam, 2018). On the other hand, rapid growth in developing countries also brought about social challenges, such as the widening of income inequality (Hao et al., 2016). The worsening of income inequality in developing countries is of major concern as the poor in these countries are dependent on the environment to assist their basic needs, thereby leading to a deterioration in the environment (Grossman and Krueger 1995). Moreover, the poorest in impoverished countries are more vulnerable and less resilient to counter the negative impacts of environmental changes (Stern, 2007; Awodumi and Adewuyi, 2020). These situations

may undermine environmental sustainability (Wu and Xie, 2020). Against that backdrop, the focus of the study is on developing countries around the globe.

3.4 Empirical Model

As explained earlier, the purpose of the study is to estimate the impact of inequality on carbon dioxide emissions. For this purpose, the following logarithmic equation is used as a baseline equation estimated by using panel data of the selected developing countries spanning between 1990 and 2020.

$$\ln C_{it} = \beta_0 + \beta_1 \ln y_{it} + \beta_2 \ln y_{it}^2 + \beta_3 \ln X_{it} + e_{it} \quad \textbf{(3.6)}$$

Where C_{it} stands for the logarithm of carbon dioxide emission per capita for country i in period t, Y_{it}represents GDP per capita and $y_{it}^2$is the square of GDP per capita, X_{it} is the vector of control variables such as urbanization, value-added manufacturing, and e_{it} is the country-specific error term.Equation (1) is a standard EKC equation that does not take into account inequality. For EKC to hold;$\beta_1 > 0$ and$\beta_2 < 0$.Now, incorporating the measure of income inequality (Gini coefficient) in equation (1), we get,

$$\ln C_{it} = \beta_0 + \beta_1 \ln y_{it} + \beta_2 \ln y_{it}^2 + \beta_3 \ln X_{it} + \beta_4 \ln Gini_{it} + e_{it} \quad \textbf{(3.7)}$$

In regression Eq. (2), the sign of β_4 will determine the impact of inequality on carbon emission. A positive value of β_4 indicates an increase in carbon emissions with greater income inequality, whereas a negative coefficient indicates decreasing emissions with the expansion of the income gap or, in other words, acceptance of the equity-pollution dilemma[36].

Equation (2) does not allow us to estimate the change in the direction of the inequality-emission relation as the level of per capita GDP changes. In order to allow the relationship between the income gap and CO_2 emissions to be contingent on income, an interactive term of GINI and GDP per capita is included in the following equation

$$\ln C_{it} = \beta_0 + \beta_1 \ln y_{it} + \beta_2 \ln y_{it}^2 + \beta_3 \ln X_{it} + \beta_4 \ln Gini_{it} + \beta_5 \ln y_{it} \ln Gini_{it} + e_{it} \quad \textbf{(3.8)}$$

[36]The idea that reduction in income gap might aggravate pollution.

If$\beta_5 > 0$, then income inequality increases environmental pollution as the economy grows, and if β_5 is negative, then the increase in income inequality will reduce the carbon emissions as the average income increases.

Finally, to test the political transmission mechanism of Boyce (1994), the political rights variable is included in equation (2).

3.4.1 Estimation Techniques

As our analysis is based on annual time series data of developing countries around the globe. Keeping in view the nature of the study, one way is cross-country regression; however, using OLS regression has some severe drawbacks. First, the cross-section estimators do not take into account the endogeneity problem of the explanatory variables, as indicated by (Caselli et al.,1996; Yalta and Yalta, 2012), that incross-country regression, most macro-economic variables are interdependent, which could yield spurious results due to biased and inconsistent estimates. Second, the inclusion of lag of the dependent variable as an explanatory variable may lead to the problem of autocorrelation in OLS regression which can make OLS estimators inconsistent and biased for small time periods) (Judson and Owen, 1999). Last but not least, the OLS estimates often suffer from the problem of omitted variable bias (Voitchovsky, 2005). To avoid the inadequacies of cross-country regression, the study will use the dynamic panel estimation technique developed by Arellano and Bond (1991) and Arellano and Bover (1995) to estimate the above regression. As Roodman (2006) stated, the dynamic panel estimation works best in the following conditions:

- when the time period (t) is small, and the number of observations (N) is large (t<N)
- when some variables are endogenously determined – the presence of lag-dependent variable
- In the case of randomly distributed fixed effects.

The use of a dynamic framework can capture the unobserved country-specific factors, therefore overcoming the problem of omitted variable bias. The study estimates the following dynamic growth model using the GMM estimation technique;

$$\Delta YC_{j,t} = \beta_0 + \beta_1 C_{j,t-1} + \beta_2 X_{j,t} + \beta_3 Z_{j,t} + \gamma_j + \mu_j + \epsilon_{j,t} \quad \textbf{(3.9)}$$

where,

$$\Delta Y_{j,t} = \text{Log difference of income per capita of country 'j' in period 't'.}$$

$$X_{j,t} = \text{Vector of standard control variables as discussed in equation 1.}$$

$Z_{j,t}$= Vector of variable(s) of interest, such as the Gini coefficient and an index of politicalrights.

$$\gamma_j = \text{Captures the sample} - \text{wide tie effect}$$

$$\mu_j = \text{Accounts for unobserved time} - \text{invariant effects specific to each country}$$

$$\epsilon_{j,t} = \text{Accounts for residual error}$$

There are two types of dynamic panel estimation methods that are frequently used in the literature, namely, the first difference GMM estimator, which was developed by Arellano and Bond (1991), and System GMM, developed by Arellano and Bover (1995). The first difference GMM uses the first difference equation with suitable lagged levels as instruments, while the system GMM uses an addition equation in levels with lagged as instruments. The system GMM has some advantages over the first difference GMM as argued and statistically proved by Bond et al. (2001) and Hoeffler et al. (2001). They argued that the use of lagged levels of variables in different GMM methodologies happens to be a weak instrument when the number of observations is small for time periods leading to serious downward large finite sample biases. On the other hand, as mentioned earlier, system GMM uses equations in level with lagged variables as instruments, thereby resulting in a decrease infinite sample bias and serious gains in precision due to the additional moment conditions. Moreover, estimators of system GMM have more satisfactory finite sample properties due to the efficient use of time-series information in system GMM. Thus, instead of difference GMM, we use system GMM for estimating our baseline model presented in equation (2) since it is expected to give robust results.

The process of estimation involves taking the first difference of equation (1), which will remove the unobserved specific time-invariant effect, hence ruling out the possibility of omitted variable bias; therefore, equation (4) becomes as follows:

$$\Delta C_{j,t} = \beta_0 + \beta_1 \Delta C_{j,t-1} + \beta_2 \Delta X_{j,t} + \beta_3 \Delta Z_{j,t} + \Delta\gamma_j + \Delta\mu_j + \Delta\epsilon_{j,t} \qquad \textbf{(3.10)}$$

Where,

$$\Delta C_{j,t} = \Delta C_{j,t} - \Delta C_{j,t-1}$$

The problem of inconsistency arising due to the endogeneity of independent variables is solved by taking as instruments lagged values of the explanatory variables. The consistency of the GMM estimator depends on the validity of the instruments used. To ensure a parsimonious use of instruments, the study uses two specification tests suggested by Arellano and Bover (1995). The first is the standard Hansentest for testing the validity of all the instruments. The Hansen test tests the null hypothesis of the validity of over-identifying instruments against their invalidity. The second test is the test of serial correlation that whether error terms are second-order serial correlated.In our case, regression with a difference first-order serial correlation is expected to be found, so the appropriate test is to examine the second-order serial correlation. Lastly, the equation is estimated by using the code xtabound2 developed by Roodman (2006). The regression analysis has been carried out ina statistical package (STATA 15).

3.5 Results and Discussion

3.5.1 Economic Mechanism

Table 3.2: Parameter estimates of economic mechanism

Group	**Full sample**		**UMI Countries**		**LMI Countries**	
	1	2	1	2	1	2
CO_2(t-1)	0.076* (0.071)	0.326*** (0.000)	0.902*** (0.000)	0.351* (0.032)	0.737*** (0.000)	0.418** (0.001)
Gini	-0.986* (0.015)	9.37*** (0.032)	-0.179* (0.094)	-25.092* (0.021)	-0.419* (0.085)	22.10* (0.029)
GDP per capita	3.091*** (0.000)	5.842* (0.005)	1.151* (0.037)	7.893* (0.089)	1.038* (0.093)	15.87* (0.020)

GDP square	-0.150** (0.009)	-0.138* (0.020)	-0.062* (0.055)	-0.1121* (0.031)	-0.053 (0.195)	-0.138 (0.238)
Manufacturing	0.420* (0.069)	0.308* (0.022)	0.038 (O.319)	0.220 (0.148)	0.149* (0.025)	0.461** (0.001)
Urbanization	0.450*** (0.005)	0.451** (0.004)	0.045 (0.499)	0.137 (0.724)	0.201* (0.015)	0.254 (0.184)
Gini*GDP		-1.220* (0.035)		2.810* (0.024)		-3.571 (0.025)
No.of observations	2095	2095	955	955	1139	1139
No.of countries	69	69	31	31	38	38
Hansen test (p value)	0.574	0.479	0.667	0.769	0.531	0.495
AR(1)	0.012	0.002	0.003	0.072	0.025	0.068
AR(2)	0.599	0.428	0.353	0.380	0.437	0.373

Dependent variable: log of per capita carbon dioxide emissions.

Note: *, **, and *** denote significance at 10%, 5%, and 1% levels respectively

The purpose of this section is to present and discuss the key findings obtained from the GMM estimation technique/of our empirical analysis. Table 1 gives the results of the inequality-emission nexus for the heterogeneous panel (full sample and two subgroups; lower and lower-middle-income and upper-middle-income countries). The estimation of the individual panels comprises two parts. The first column of the regression provides the result of the main explanatory variables besides control variables, and the equation in the second group performs a regression by including an interactive term of GDP and income inequality.

The dependent variable is the log of CO_2 emission per capita, and the main explanatory variables are the income inequality measured by the Gini coefficient, the logarithmic value of GDP per capita, and its square term. The lag of the dependent variable is also included to address the problem of unobserved heterogeneity. It is

imperative to explain that lag of the dependent variable, urbanization, and manufacturing value-added are control variables in our regression analysis.

As shown in column 1 of Table 3.2, income inequality is negatively and significantly related to CO_2 emission for the whole sample of countries. Specifically, a 1% increase in income inequality will decrease carbon emissions by 0.98 percentage points. The findings imply that the economic transmission mechanism of diminishing marginal propensity to emit (MPE) exists; that is, unequal distribution of income towards the rich is beneficial for the environment and will help in the reduction of CO_2 emissions (Heerink et al., 2001; Ravallion et al., 2000; Guo, 2014). The plausible explanation for higher MPE is twofold. One is the inability of the impoverished segments to use environmentally friendly products and reliance on traditional fuel for energy needs (Magnani, 2000; Hao et al., 2016). Another is linked with diminishing MPE coupled with the Keynesian concept of diminishing MPC. In other words, the transfer of income to the poor (decline in inequality) will increase not only consumption but also emission due to higher MPC and MPE of the poor segment, hence more emissions (Berthe and Elie, 2015; Hailemariam et al., 2020). The results are in line with/support the findings of the empirical studies of Islam and Abdul Ghani (2018) in the context of the ASEAN region, Koçak et al. (2019) for Sub-Saharan Africa; and Rojas and Lastuka (2020), and Hailemariam et al. (2020) for OECD countries. Moreover, the result continues to hold even when the sample is split into two sub-groups; the inequality coefficient has a negative and significant impact on the CO_2 emission of the upper-middle-income countries and low and lower-middle-income countries. Empirical results show that there is a trade-off between inequality and carbon emission, and a one percent increase in income inequality will reduce carbon emission by 0.419 percentage points in the low and lower-middle-income group and 0.17 percentage points in upper-middle-income countries.

Next, to test whether the relationship between the income gap and carbon emission is affected by the level of economic development, an interactive term of inequality and GDP per capita is added. The idea is that two economies with the same level of inequality but different income levels may affect emissions differently. If country X's income level allows its citizens to enjoy a better living standard while country Y's level of income barely allows its citizens to meet basic necessities, then

inequality changes may affect environmental pollution differently. The finding is worth noting. The coefficient of Gini, which was negative for all the groups, sharply increased to positive in the entire sample and for low and lower-middle-income countries, while the negative association between income inequality and carbon emission continues to hold for upper-middle-income countries. The interactive term is positively and significantly related to emissions in the case of upper-middle-income countries, while for the other two groups, the coefficient of the interactive term is negative.

Regarding the control variables, the coefficient of per capita GDP has a significant positive effect on the emission rate, while the square of per capita income is negatively related to the emissions, thus showing an inverted U-shaped trend and confirming the existence of the EKC hypothesis across all panels. The U-shaped curve implies that an increase in per capita GDP aggravates CO_2 emission at the early stages of development, while the effect gets reversed after achieving a certain level of GDP.

Looking at the magnitude tells us that the effect is quantitatively larger in the case of upper-middle-income countries than in low and lower-middle-income countries. Specifically, a one percent rise in GDP per capita will increase CO_2 emissions by 1.1 percentage points in UMI countries while 1 percentage point in the case of low and lower-middle-income countries. The result seems logical for developing countries as these countries are at the early stages of development and often tend to ignore the harmful effects of economic development on environmental degradation (Khan, 2019). Our results coincide with the previous findings reported by Grossman and Krueger (1991), Coondoo and Dinda (2002), Golley and Meng (2012), Ali et al. (2017), and Usman et al. (2019).

As far as other control variables are concerned, the lagged value of the dependent variable CO_2 (t-1) tends to increase the carbon emission in the current period. This behavior may be related to sluggish variables such as technology, human capital, and institutional factors that make it difficult to rapidly reduce emission levels. Finally, the regression coefficients for manufacturing and urbanization in the whole sample and lower-middle-income countries are positively and significantly related to carbon emission. A similar result has been confirmed by many previous studies (Feng

et al., 2009; Wan and Wang, 2014; Grunewald et al., 2017; Aller et al., 2015; Wan et al., 2022). However, we do not find significant results for manufacturing and urbanization in the case of upper-middle-income countries.

3.5.2 The Political Mechanism

As discussed earlier, to test the political mechanism of Boyce (1994), the study includes the political rights variable along with other control variables.

Table 3.3: Estimated parameters of the political mechanism

Variables	Full panel	UMI countries	Lower-middle income
CO_2(t-1)	0.285*** (0.006)	0.287** (0.008)	0.2596* (0.017)
Gini	-1.465*** (0.006)	-1.099*** (0.001)	-1.7061** (0.004)
GDP per capita	3.745*** (0.000)	0.948* (0.029)	1.514* (0.017)
GDP square	-0.191*** (0.000)	-0.037* (0.054)	-0.038* (0.017)
Manufacturing	0.456** (0.001)	0.355* (0.014)	-0.592** (0.002)
Urbanization	0.515* (0.002)	0.123 (0.638)	0.609** (0.001)
Political Rights	-0.145* (0.074)	-0.084* (0.043)	-0.058 (0.388)
No. of Countries	68	31	38
Hansen Test(p-value)	29.00 (0.517) (0.867)	14.75 (0.987)	16.42 (0.970)
AR(1)	-1.84 (0.066)	-1.93 (0.054)	-2.63 (0.008)
AR(2)	-0.14 (0.891)	-1.44 (0.149)	-0.36 (0.716)

The results show that the negative relationship between income inequality and carbon emission continues to hold and remains significant and is not affected by the inclusion

of another variable. This suggests that the effect of inequality on emissions persists beyond these plausible transmission channels. The result shows the negative impact of the Political Rights variable in the case of upper-middle-income countries, while a relationship does not exist in the case of low- and lower-middle-income countries. The literature supports this finding as in more rich countries, it is easier to reach a social consensus regarding the environment. Also, the relative power of groups that benefit from emissions is weaker as compared to poor countries. This result infers the dominance of political effect as the country gets richer and the existence of the political-economic approach of Boyce(1994) and Boyce (1997) in the case of upper-middle-income countries. A similar result was found by Rojas and Lastuka (2020).

3.6 Conclusion

The key objective of the study was to carry out an empirical investigation to test the inequality-environment nexus. It is crucial to explore this nexus, given the fact that both have worsened over time and need immediate/urgent solutions. The situation is gloomier in developing countries as the lower segment in the poor countries is more exposed and less equipped to encounter the negative impacts of environmental changes (Stern, 2007). To empirically analyze the economic as well as political transmission mechanism, the study employs a panel of developing countries around the globe over the period from 1990 to the latest.The panel is then subdivided into two groups of upper- and low- and lower-middle-income countries. The study uses the dynamic panel technique of system GMM to tackle the econometrics issues of endogeneity and unobserved country-related effects.

The descriptive analysis depicts a negative correlation between income distribution and the emission of CO2. The empirical outcomes confirm this negative correlation between the two, and the results do not change when the aggregate sample is divided into sub-samples. In all three groups, results indicate the existence of a negative relationship between income inequality and CO2 emissions. The inequality elasticity of carbon emission is -0.98 in the aggregate panel, suggesting that, on average,a one percent increase in income inequality will increase pollution by 0.986 percent, while the value of inequality elasticity is-0.18 and -0.42for upper-middle income and lower middle-income groups respectively. The results show that the poorer the country, the

larger the value of inequality elasticity on carbon emissions. More specifically, the results confirm that economic (consumption) mechanisms hold: as the poor segment gets more income share (or in other words, income inequality decreases), emission level increases and consequently disrupts the environmental quality. The existence of a trade-off between income inequality and carbon emissions seems pertinent in developing countries, as a large share of the population in these countries produces fewer emissions due to non-dependency on the carbon economy, while the rich in these countries already have low MPE than the poor segments. Additionally, the study also explored the political mechanism, and wefind thatthe political mechanism holds in the aggregate sample, which means that political freedom does influence the inequality-emission nexus.In contrast, disaggregated analysis of upper-middle and low and lower-middle-income groups shows a heterogeneous result. Political freedom negatively and significantlyimpact carbon emissions in the case of upper-middle-income countries, while the relationship does not hold in the case of low and lower-middle-income countries. The existence of a political economy mechanism in the case of upper-middle-income countriesindicates that as countries get more political freedom, carbon emission decreases as it is easier to have a social consensus on designing environmental policies due to the weaker bargaining power of the groups that benefit from emissions. Finally, the results also support the presence of the EKC hypothesis in all the estimations. Both urbanization and manufacturing positively affect carbon emissions.

The study findings of a negative elasticity of income inequality on carbon emissions may disappoint those wishing for a win-win outcome of low emissions and low inequality. From the policy perspective, this finding has important implications for policymakers who wish to improve income inequality. On the face of it, it appears that any policy aiming at improving the income gap will contribute to environmental pollution. However, as stated by Scruggs (1998), the existence of a tradeoff does not necessarily imply that income redistribution is undesirable; rather, it highlights the need for more coordinated and balanced policiesto get socially desirable outcomes. The literature highlights a number of effective policies to target either inequality or pollution, but the result of this study indicates the need to take two issues together for policy purposes. One such policy to successfully tackle this trade-off could be to

promote rural electrification with renewable energies. Recent studies highlight a negative relationship between income inequality and the use of renewable energies (Dinkelman, 2011; Uzar, 2020). These findings broaden the scope of policymakers' to institute a targeted coupon system along with targeted subsidies and incentives to promote the use of solar energies. Thereby, a win-win outcome of reducing emissions and narrowing the income gap can be achieved. Additionally, the existence of the EKC hypothesis in the study impliesthat inclusive growth is the ultimate measure that can contribute to the win-win outcome, as growth will, in the end, lead to reductions in CO_2 emissions.

Clearly, future research is warranted to search for a market-based policy that can endogenously tackle inequality and emissions. These findings highlight the need for further research, including exploring in greater detail the relationship between emissions and the profile of income distribution.

In this study, we show how different income groups relate to carbon emissions in different ways within countries. Furthermore, we find that at low stages of development, productivity effects dominate over political ones. However, the reverse may hold at higher stages of development. As countries become richer and access the technological frontier, this could decrease their emissions level. Understanding the relationship between carbon emissions, inequality, and growth is crucial if we pursue to maintain or improve our standard of living while minimizing the damage to our ecosystem.

The positive result of education indicates the need to focus on providing education opportunities, particularly for individuals fromdeveloping countries.In the case of climate change, however, general education is insufficient. For such a scientifically complicated topic, the sort of education also matters; while general education plays a role, specialized education is also essential. One practical solution can be adding more lectures on the dangers of environmental problems, and threats into the school curriculum could enhance environmental concerns.

4. EXAMINING THE DETERMINANTS OF INDIVIDUAL'S ENVIRONMENTAL CONCERN: EVIDENCE FROM CROSS-COUNTRY ANALYSIS

4.1 Introduction

The growing concerns about the state of the natural environment/planet, protection of endangered species, and maintenance of ecosystems have renewed the attraction of policymakers around the world to take necessary actions for sustainable development. As a result, many national governments and international environmental agreements call for increased worldwide efforts to safeguard the environment and, in particular, to cut greenhouse gas (GHG) emissions in order to reduce global warming. The scientific evidence suggests that climate change is a significant problem that will cause drastic changes in the earth's ecosystem and its negative consequences include rising sea levels, melting glaciers, reduction in crop yield, deforestation, changes in regional climate (Oskamp, 2000; Claesson and Nycander, 2013), increase in crime rates (Rotton and Coin, 2003), armed conflict and failure of state (Salehyan and Hendrixz, 2014), thereby a threat to the existence of human's life (Intergovernmental panel on climate change(IPCC, 2001).

Scientific evidence suggests that the main cause of climate change/GHG emissions is related to human activities (Nordlund&Garvill, 2002; Schmuck &Franěk, 2005), and sources of pollution have shifted from activities of production to consumption patterns (UNDP, 1998), which are placing unprecedented pressure on the environment. In this light, protecting the environment requires fundamental changes in the behavior of individuals. It is, therefore, crucial for the citizens to not only share their concerns for the improvement of environmental quality but are also willing to incur the associated costs (IPCC, 2018).

The need for increasing environmental consciousness has shifted the focus of social research to explain the factors affecting the individual as well as the cross-national differences in public environmental awareness.

However, the way in which individual and cross-national differences have been explained is subject to a lively debate. Ronald Ingelhart's (1977) thesis on post-

materialism lies at the core of this ongoing debate. Inglehart argued that concerns about environmental problems are more prevalent among the individuals of rich countries because of a general shift in fundamental values from issues of physical sustenance to post-materialistic(quality of life) in modern societies, whereas individuals of poor countries have to remain focused on their basic needs. On the contrary, some authors such as Dunlap and Mertig (1997) have opposed this view and argued that environmentalism has become a global phenomenon- not just confined to affluent countries, a finding which has lately been reconfirmed by many empirical studies (for instance, Brechin, 1999; Gelissen, 2007; Dunlap & York, 2008).

Moreover, a third perspective known as the 'prosperity thesis' holds the view that the concern for the environment does expand with the increase in income level. However, this positive association between income and environmental concern is not necessarily contingent on a shift to post-materialist values (Diekmann and Franzen, 1999; Franzen, 2003; Franzen and Meyer, 2010), as argued by Inglehart's post-materialism hypothesis. In addition, other pieces of research indicate that residents' willingness to pay (WTP) for environmental protection is likely to be higher in developing countries due to the presence of more severe environmental problems; consequently, there may be an inverse relationship between WTP for environmental protection and income level in developing countries (Dunlap & York, 2007).Therefore, the theoretical debate is still inconclusive.

The extant empirical literature on environmental attitudes has explored a number of factors that determine the individual's pro-environmental behavior and, by extension, drive individuals to contribute toward the provision of a public good such as the environment. These factors include a set of demographic factors such as sex, education, age, and income (Brechin and Kempton, 1994; Stern and Dietz, 1994; Dunlap and Mertig, 1995, 1997; Stern and Guagnano, 1998; Dunlap and Jones, 2002; Gelissen, 2007; Franzen, 2003; Dunlap and York, 2008; Franzen and Meyer, 2010; Knight and Messer, 2012). In addition, the literature has also identified a set of values such as religious beliefs, the post-materialism index of Inglehart, and finally, the inclusion of the role played by social capital, such as trust level (Meyer and Liebe, 2010) in shaping individuals pro-environmental attitudes.

Most of these studies, however, have been conducted in developed countries due to the early presence of concern for the environment in these countries. The empirical literature on environmental concerns can be divided into two groups on the basis of sample selection; country-specific analysis and cross-country analysis, mostly including a small number of countries.

Country-specific research focused on countries as diverse as China (He and Zhang, 2021; Wang et al., 2021), Australia (Ivanova, and Tranter, 2004), United States (US) (Van Liere and Dunlap, 1981; McKeever and Rothenbach, 1998; Dunlap et al., 2000), Canada (Edgell and Nowell, 1989; Zhou, 2013),Britain (Norris, 1997), Norway (Olli et al., 2001), Korea (Kim, 1999), Switzerland (Meyer, & Liebe, 2010), Turkey (Goksen et al. 2002), Egypt (Mostafa 2007), Spain(Torgler and Garcia-Valinas, 2007), New Zealand (Milfont, & Cameron, 2006).

In addition, cross-country studies which have investigated the determinants of pro-environmental behavior are less frequent and include less number of countries. The comparative research differs in terms of measures of environmental concern, analytical techniques, and use of data sets. Cross-sectional studies include a comparison of environmental concern in Mexico and Brazil (Bechtel et al., 1999), in the US and Russia (Dalton et al., 1999), in five countries comparison including Russia, US, Great Britain, Japan, and West Germany (Weaver, 2002). Other comparative studies measure environmental concern in a relatively large number of countries 24, 35, 40, 42, 50, and 59 countries, respectively (M. Dorsch, 2011; Duroy, 2008; Dorsch, 2014; Mohamed, 2016; Running, 2015; Gelissen, 2007;Franzen& Meyer, 2010; Katrina, 2015; Hao, 2016; Combes. et al., 2018).

The present study builds on the previous literature with some extensions. In particular, the study aspires to test the competing hypotheses of Post materialism, globalization, and affluence theory on individuals' pro-environmental behavior. However, the following extensions have been made. First, the current study improves on existing literature by assessing the data from a relatively larger group of countries having diverse levels of economic development, which makes it possible to generalize results to other nations not included in the sample. The study includes 106 countries of the world, out of which 41 developed and 65 countries from developing regions

(both upper-middle and lower-middle income countries) have been analyzed. The present study compares a sample of countries by dividing them into developed and developing regions.

Second, the study analyzes data from seven waves of World Values Survey (WVS) data. To the best of our knowledge, none of the previous studies have used such a large data set. Most of the previous literature has used data from one point in time; the only exception is the study of Hao (2016) which uses data from four waves of the WVS data set. The present study uses data sets from all seven waves covering 2018 to unpack the factors behind individuals' willingness to contribute to environmental quality improvement.

Last but not least, the present study uses a richer set of independent variables as compared to the previous literature. This helps to analyze several hypotheses; for example, the study will explore the impact of institutional quality on the environmental attitudes of individuals across countries. Moreover, the rapid growth of the social capital literature inspired our efforts to check the importance of these variables on the differential in individuals' environmental attitudes among developed–developing countries.

Such an empirical investigation demands a rich and well-elaborated data set. Thus, the study uses the data set of the World Values Survey to carry out an empirical investigation. WVS data set provides information on a rich set of variables in a large number of countries and regions and is well suited to investigate the hypothesis of the current study.

The paper proceeds as follows. Section two reviews the extant theoretical and empirical literature. We then present the data and methodology, followed by empirical findings. The last section concludes the paper.

4.2 Literature Review

4.2.1 Theoretical Contribution

The purpose of this section is to provide an overview of the competing theoretical approaches that discuss the individual and country-level differences in environmental attitudes towards the environment.

Concern for the environment can be defined as the awareness or understanding on the part of individuals that the natural state of the environment is in danger as a result of humans'excessive use of resources and degradation of the environment (e.g., Dunlap and Jones, 2002). There are at least three major schools of thought that attempt to provide an explanation for this variation. These approaches include the post-materialism hypothesis developed by Inglehart (1995, 1997), the prosperity or affluence hypothesis, which is founded on classical economic theory and has recently been confirmed by Diekmann and Franzen (1999), and finally global environmentalism hypothesis of Dunlap et al. (1993, 1995, 1997).

The post-materialistic theory of Inglehart (1977, 1990) is based on a fundamental change in intergenerational values that take place as a result of substantial economic development. The basic idea is that as countries develop and modernization occurs, survival needs or material concerns no longer have to be the prime consideration; human beings being liberated from the economic struggle of basic physiological needs, such as access to food and the need for physical safety can instead/tends to prioritize/ pursue other goals. Inglehart termed such goals as post-materialistic values, which include freedom of expression, human rights, and concerns for environmental quality/environmental protection. Thus theory posits that post-materialism is a phenomenon prevalent in rich countries. Up until the beginning of the 1990s, the post-materialist explanation for cross-national patterns of environmental concern was broadly accepted without being questioned. The increasing environmental activism in poor nations, as demonstrated by their participation in the Global Forum in Rio in 1992 (Fisher, 1993), as well as the findings of the Health of Planet (HOP) survey conducted in 1992, indicated that citizens of poor nations possessing more materialistic values had higher levels of concern than the post-materialist perspective assumed they would have (Dunlap et al., 1993; Brechin and Kempton, 1994; Dunlap and Mertig, 1995).According to Brechin and Kempton (1994), the formation of environmental concern is far more complex than a perspective that merely considers changes in economic prosperity as a determinant of environmental concern.

Faced with the contrary evidence, Inglehart (1995) amended his theory to include his objective problems and subjective values (OPSV) hypothesis. OPSV

hypothesis attributes the concern for the environment in the poor countries to the objective problems, which means/argue that the individuals' concern for the environment in the poor countries stems from the need to overcome serious and immediate local problems, such as lack of clean drinking water, polluted cities, or lack of access to adequate sanitation, while developed world faced with less of such problems shows pro-environmental behavior for reasons justified by Inglehart's original thesis of post materialistic subjective values.

Thus, Inglehart put forward two independent effects on pro-environmental attitudes: first, a positive effect of post-material values and, second, a negative relation between environmental quality and the concern for the environment, e.g., better the environmental conditions, the less concern for the environment.

A similar approach that has its origin in the orthodox economics literature is called the 'propensity or affluence hypothesis". According to the standard economic reasoning, a rise in income levels would stimulate the consumption of high-quality goods. Since environmental quality is perceived as a luxury good, growth in national or personal income shifts demand for environmental quality upwards (Franzen, 2003; Franzen and Vogl, 2013). The logic is that if the population in poor countries with scarce resources devotes their resources to the betterment of the environment, these resources can no longer be devoted to the consumption of other goods. Therefore, as a population becomes wealthier, there should be an increase in the demand for a higher level of environmental quality. This should, in the aggregate, result in a positive correlation between the intensity of measures taken to improve the state of the environment and the level of wealth that the country possesses.

Thus it is hypothesized that people in rich countries with low economic pressures and more freedom are more likely to exhibit a stronger demand for a clean environment than individuals from poor countries.

Although the theoretical specifications of the post-materialistic and affluence hypothesis vary[37], the implications of both hypotheses do not contradict, and both

[37]Post-materialistic hypothesis focuses on the link between economic development and value shift which leads to increase environmental concern, while propensity hypothesis suggests a more direct connection between economic development and concern for environment.
Post materialistic hypothesis: Economic development →shift of values→ environmental concern↑

emphasize a positive connection between environmental concern and affluence. In a nutshell, both hypotheses imply that after reaching a certain baseline level of material security,people are more inclined to give resources to safeguard the environment, even if it means lowering their living standard (Diekmann and Franzen, 1999; Franzen, 2003; Franzen and Meyer, 2010).

However, there is a third approach known as 'global environmentalism,' which is in contrast to the above two hypotheses and postulates that there is not a significant correlation between the level of national income and environmental concern, and even if there is, it is likely to be a negative correlation.

In the late 90s, some studies empirically showed that post-materialism did not hold at the cross-national level, and as opposed to the previous understanding that environmental concern is generally found among the elites of wealthy nations, they claim that it has spread to the general population. (e.g, Brechin and Kempton, 1997; Dunlap and Mertig, 1997). In a similar vein, Dunlap and York (2008) failed to find empirical support for the post-materialism and affluence hypothesis. Authors argued that due to global warming and other environmental challenges, protecting the environment has become a universal priority, and environmental protection has also become a global phenomenon and is not confined to the country's affluence level or country's wealth as proposed by Inglehart. Critics argue that the inclusion of "objective problems" was made in a post hoc manner to overcome the empirical deficiencies with the theory's original formulation (Dunlap and York, 2008). They support their claim with empirical evidence with data from three waves of world values survey, and findings indicate that concern for the environment has a negative correlation with the degree of wealth at the national level (Dunlap & York, 2008).

In fact, residents of developing countries may have a higher willingness-to-pay (WTP) for environmental protection because economic development in developing countries typically comes at the expense of the environment, and because of this, residents of developing countries are more likely to be affected by environmental pollution (Franzen & Meyer, 2010).

Affluence hypothesis: Economic development→ environmental concern↑

So far, we have discussed three distinct hypotheses, namely concerns for the environment. In the subsequent section,the review of the existing empirical literature on the correlations between environmental concern and other factors has discussed.

4.2.2 Empirical Literature

The empirical literature on the determinants of environmental concern can be divided into two groups; country-specific analysis and cross-sectional analysis.

4.2.3 Cross-Sectional Studies

Gelissen (2007) examined environmental preservation initiatives in 50 different nations around the world. Researchers uncovered significant differences between the ways in which countries pay for environmental protection by analyzing data from the World Values Survey and the European Values Study that was conducted between 1999 and 2000.The findings of the study indicate that there is a connection between environmental protection and factors such as income, education level, personal preferences, and age.

Dorsch (2011) tested the Objective problem and Subjective values (OPSV) hypothesis of Inglehartn by using the 5^{th} wave of the World Values Survey in 24 developing economies. The results showed subjective values to be an important determinant of environmental concern than local or objective problems as opposed to what theory formulates.

Franzen and Vogl (2013) examined the relationship between GDP and WTP for environmental protection. The study discovered that countries with a higher national income have a stronger WTP for reducing emissions. Comparatively, countries with lower national incomes have a lower WTP for pollution reduction.Therefore, wealth is positively associated with WTP's ability to cut down on pollution.

Duroy(2008) also found evidence in support of the affluence hypothesis. The study was carried out by using data from World Values Survey (1995–1997). Along with income, other important drivers include population density, education levels, and subjective well-being.

The positive impact between wealth and willingness to pay could not be established in a study carried out by Mohamed (2016). The study used data from forty countries to test the affluence hypothesis. Results do not support the affluence hypothesis that posits income to be an important determinant of pro-environmental behavior. On the contrary, the study found religious belief and political orientation to be important determinants of environmental concerns.

Running (2015) investigated the factors that affect individuals' behavior to choose between the environment and economy and willingness to contribute financially to environmental protection. The study used data from WVS (2005-2008) for 42 developed and developing countries, along with contextual-level data from World Bank development indicators(WDI). Findings revealed that individuals in developing countries are more willing to contribute financially than to prioritize the environment over growth.

Hao (2016) examined numerous environmental anxiety variables in 82 states using multivariable panel regression. This data was collected through the International Social Survey Program.According to the findings of the study,deeper environmental concerns are linked to both environmental degradation and its favorableassociation. In addition, there is an inverse relationship between one's level of economic riches and their level of happiness.Significant challenges have a wide range of effects that can be detrimental to public concerns for the environment.Additionally, it can be a universalistic element that accounts for all variations in environmental care.

In another cross-country comparison study, Combes et al. (2018) used individual and country-level covariates to investigate the individuals' pro-environmental behavior. His study used the fifth wave of the World Values Survey for differences in environmental attitudes between developing and developed countries. By applying a two-level logistic regression, the results of the study revealed that 81% of the variation among developed and developing countries comes from individual-level covariates, while country-level covariates explain the remaining 19% of the total variability in environmental awareness across nations.

Mayerl and Best (2018) empirically tested the post-materialism and OPSV hypotheses for a group of developing and developed countries. The study used a

combined data set of WVS (waves 5 and 6) and ISSP (2010). The results of the study indicate that the post-materialism hypothesis holds in wealthy countries, but the effect turned out to be weak in the case of developing countries.

Maki et al. (2016) performed a meta-analysis of 22 studies to examine WTP for environmental protection and the role of financial motivation in endorsing pro-environmental activities. The findings of the study indicated that motivating factors have little effect on behavior.In addition, monetary incentives were found to be more effective in modifying particular environmentally friendly habits. Monetary incentives were found to have a more significant impact on reprocessing, but non-cash incentives were found to have a bigger impact on travel behavior.According to the findings of the study, financial considerations can influence environmentally conscious behavior, play a role in the maintenance of that conduct over time, and can be especially effective in certain settings.

4.2.4 Country-Specific Studies

Torgler and Garcia (2007) investigated the drivers of environmental concern in Spain. Their study used the combined data of the European Values Survey (EVS) and WVS. They discovered that variables such as trust and education strongly affect individuals' willingness to contribute to environmental protection.

Shao et al. (2018) examine the effect of income on WTP for environmental conservation in China. The data was collected from a 2010 Chinese general social survey and satellite monitoring information. Using the Logit model, the effect of income level on WTP for environmentally friendly behavior was explored. According to the results of the study, persons with a higher income have a greater WTP than those with a lower income. WTP increases with increasing income until it reaches a certain amount, after which it tends to fall. In contaminated regions, WTP was greater than in less polluted regions. As a result, WTP will be influenced by factors other than money, including levels of pollution, environmental awareness, and education.

Ivanovaand Tranter (2004) analyzed the factors that promote pro-environmental behavior among Australian citizens. The study used data from the Australian Survey of Social Attitudes and found education, post-materialistic values, and trust to be positively and significantly related to the individuals' willingness to

contribute to the environment, while gender, age, and income turned out to be poor predictors of environmental concern. Lera-Lopez et al. (2014) examined the effect of the public transportation system on pollution management in rural areas in the western Pyrenees of Spain. A stratified random sampling strategy was adopted to recruit 900 respondents for the direct interview approach. According to the findings of the study, people who live near major roads pay higher WTP taxes to prevent air and noise pollution. The findings of the study showed that those who reside in close proximity to major roads pay higher WTP taxes in order to mitigate the effects of air and noise pollution. Young people who are highly educated and aware of the environment, pollution, and threats have a larger willingness to pay (WTP) to preserve the environment.

Wang et al. (2015) investigated the preferences of parents for the provision of a clean environment for their children in residential neighborhoods and hospitals in Shanghai, China. The contingent valuation technique (CVM) was applied in order to assess the WTP's potential to improve public health by reducing levels of air pollution. The Probit model was utilized in order to establish the nature of the connection that exists between the WTP and related environmental concerns, the well-being and income of children, and the educational status of individuals. According to the findings, seventy percent of respondents were ready to pay in hospitals; however, in residential neighborhoods, that number dropped to only 52 percent. It was shown that there was a positive correlation between WTP and people's income as well as their level of education. This survey found that parents were also willing to pay for improved air quality in order to protect the health of their children. The study suggested that future environmental programs should be carried out with greater rigor for specific populations. In another web questionnaire-based study, Attaran and Celik (2015) examined the relationship between a clean environment and university enrollment. The study used statistical approaches such as ANOVA, t-tests, and correlation and found a strong association between university enrollment andWTP for a clean environment are related.Additionally, the findings show that male students are less worried about the environment than female students.

Wang et al. (2016) conducted research in China to investigate people's awareness of smog and air pollution as well as their readiness to pay for ways to clean

up the environment.Based on the results of the survey, sixty percent of respondents agreed to give funds to battle air pollution. The result indicated education, income, age, and occupation to be positively correlated with WTP.Another important determinant was knowledge about environmental problems, which motivates people to pay for a clean environment.

Mamun et al. (2018) evaluated consumer preferences in Peninsular Malaysia regarding the usage of green products. The researchers employed a cross-sectional model and gathered information from 380 responsible household heads. According to the findings of this study, environmental education and awareness favorably affect the use of green products. Additionally, low-income households were willing to contribute to environmental conservation. The study stated that to increase WTP for environmentally friendly products; the government should increase knowledge regarding public awareness of environmental issues.

Wei and Wu (2017) conducted research on the effectiveness of a public WTP tax in China for the purpose of reducing air pollution. The data was analyzed through the application of the contingent valuation method. The findings indicate that 89 percent of respondents are willing to pay to minimize air pollution, whereas 11 percent of respondents agree that the government and emitters should pay for environmental protection. In addition, factors such as wealth, age, and education all have an impact on the typical WTP.

Zhou (2013) investigated the determinants of environmental concern among Canadian citizens and found that individuals with a higher level of education and those who are aware of global environmental degradation likely to care more. For Ghana, White and Hunter (2009) examined the factors influencing environmental concern among coastal-dwelling Ghanaians and found education and post-materialistic values as important factors.

Freeman et al. (2019) investigated Chinese residents'attitudes toward air-cleaning fees. They applied the equilibrium sorting model to determine how people respond to a pollution charge. The findings of the survey indicate that the majority of respondents are prepared to pay to combat air pollution. According to the study, changes in ecological value have significant effects on human well-being. Yang et al.

(2019) investigated numerous environmental challenges.Using panel data from 288 cities in China from 2011 to 2016, the Badu Index was used to hypothesize variables identifying the community's ecological concerns. The study recommended that the government usually employs environmental organization strategies such as management, market participation, and community involvement, thereby forming a comprehensive policy organism.

Using a unique data set of Internet purchases in China, Sun et al. (2017) discovered that households invested more in masks and air filter items when pollution levels exceeded important warning criteria.However, the affluent were more inclined to invest in more expensive air filters than masks. This indicates that the poor are disproportionately impacted by environmental contamination. When faced with environmental degradation, the rich might protect themselves through private markets more effectively than the impoverished. Therefore, after a given level of environmental protection expenditure in private markets, the rich may have a decreasing WTP for environmental protection. It is important to note, however, that the negative effects of environmental pollution on inhabitants'health are not uniform, as individuals'income levels vary. Compared to the rich, the poor are more likely to be subjected to environmental pollution, which may raise their medical costs and human capital loss. Consequently, the negative effects of environmental contamination are more severe for the poor.

Nwofoke et al. (2017) conducted tests in Nigeria on the effectiveness of the WTP in minimizing pollution. The findings indicated that there was a willingness on the part of 95% of households to pay for waste disposal services. WTP is significantly impacted by factors such as income, level of education, the volume of solid waste, and the low cost of transportation. On the other hand, factors such as family size and high transportation expenses have a negligible effect on WTP.Enhancements to services for the disposal of garbage, plants for recycling, and public knowledge about the need for composting could all contribute to the protection of the environment.

Han et al. (2019) explored WTP to eliminate the use of discharged materials, a significant concern in rural China. They examined the community WTP for reducing solid pollution using surveys and statistical approaches. Males and the wealthy had a

higher WTP than females and the poor, according to the findings. Education, environmental programs, and general awareness of lowering pollutants were found to be key determinants of WTP. Future actions, such as awareness forums, should be carried out to boost society's knowledge of the necessity to prevent pollution pertaining to rural waste.

Veronesi et al. (2014) investigated the link between WTP to address the health problems brought on by water pollution in Switzerland. As per the survey results, 71% of consumers pay high WTP taxes to avoid health risks and water contamination.

Song et al. (2016) conducted research in Macau to determine the public's preferences for the reduction of solid waste. The information was gathered by the use of a questionnaire with a total of 250 participants, and then it was evaluated through the application of logistic regression.The results of the study indicate that individuals have a greater level of environmental knowledge, are satisfied with the facilities that are now accessible, and are willing to pay more for a sterile environment.

Halkos&Matsiori (2012) showed in their study that those with a greater level of education and those who pay closer attention to environmental contamination have a higher WTP for pollution prevention and that the rich are more likely to have these qualities.

Overall, the vast majority of extant empirical literature employed various data sets and econometric techniques and somewhat produced mixed results in an attempt to test the different hypotheses regarding pro-environmental behaviors. Most of the studies use a smaller group of countries with data analysis for limited time periods. In this context, the literature calls for studies giving more clarity on the determinants promoting pro-environmental behaviours using a larger data set and time dimensions to improve our understanding of environmental concerns.

4.3 Methodology and Data

4.3.1 Data

The study uses data from seven waves of the World Value Survey (1981-2020), which assess the individual-level responses to a number of questions measuring environmental concern, as approximated by their stated willingness to make economic

sacrifices for the sake of the environment. The study includes 106 countries of the world, out of which 41 developed and 65 countries from developing regions (both upper-middle and lower-middle income countries) have been analyzed. However, not every question was asked in each wave or for each country within each wave. (see Appendix A for further details).This data set is especially helpful for investigating the correlates of environmental attitudes since it provides information on a wide range of background factors in addition to a wide range of attitudinal indicators.Therefore, the current analysis uses information on relative incomes, employment status, education levels, and post-materialist values as potential determinants of environmental attitudes.

4.3.2 Variables

- Dependent Variables

The primary dependent variable is a measure of environmental concern. The study uses two dependent variables, each of which is intended to reflect a distinct aspect of environmental concern. The first dimension, willingness to pay taxes, measures the degree to which citizens are ready to make personal financial/economic sacrifices for the protection of the environment. It is measured by a binary variable which is generated from responses to the following question: To what extent would you be willing to pay more taxes for environmental protection? The responses categories consist of four alternatives (strongly agree, agree, disagree, or strongly disagree. The study combines the categories of "strongly agree" and "agree "as "1"and "strongly disagree" and "disagree" as "0"to create a binary dependent variable. In the second measure, respondents choose between two statements pitting economic growth against environmental protection. This measure reflects the individuals 'environmental protection priority and is measured by a binary variable (coded as 1) if a person views environmental protection to be more crucial even if it implies slower economic growth and some employment loss, and '0'otherwise. The reasons to include these measures of environmental concern are many folds. First, these measures have been utilized in previous cross-national comparisons/environmental concern research (Gelissen, 2007; Dunlop and York, 2008; Knight and Messer, 2012; Milfont and Markowitz, 2016). Second, among many other measures of environmental concern, these two questions were the most consistently asked across all waves of the World Values Survey. Therefore, we focus on these two only to maximize the number of countries and years.

- Explanatory Variables

To gain a better understanding of the elements that influence an individual's willingness to pay in order to prevent the deterioration of the environment, we make use of information on a variety of socioeconomic and demographic factors[38], such as income, employment status, level of education, sex, age, marital status, level of religiosity, the number of children living in the household, trust(both general and institutional level trust), adhesion to environmental organizations, and post materialistic index from the WVS. Age is suggested to be the consistent predictor (Dietz et al., 1998) among socio-demographic factors, and it is argued that young people display more pro-environmental attitudes than elderly people. This is due to the fact that older people will not live as long to enjoy the advantages of preserving resources for the future (see Dietz et al., 1998; Torgler and Garcia-Valinas, 2007).

Education is considered as another consistent predictor, and most of the studies have shown that more educated individuals with a better understanding of environmental problems are more likely to be greener than less educated ones and are more willing to spend for environmental protection (Olli et al., 2001). Nevertheless, some studies found contradictory results for the variables of age and education. For instance, Tranter and Western (2003) suggested a weaker association between younger people and their willingness to pay for the environment. Similarly, Grønhøj and Thøgersen (2009) also found evidence thatolder people engage in greener activities than young ones.For the education variable, Uyeki and Holland (2000) study found an insignificant impact on pro-environmental behaviors and education. In addition to age and education, studies have examined gender variations in environmental concern literature.When compared to age and level of education, gender is a less consistent predictor, as seen by inconsistent results across research. Some studies found that, on average, women are more inclined than males to pay financially forenvironmental protection (Stem et al., 1993; Bord andO'Connor, 1997; Chua and Aldrich, 2000; Zelezny and Yelverton, 2000; Franzen andMeyer, 2010; McCright, 2010; Collins et al., 2017; Alavi, 2020). In another study, Hunteret al. (2004) offers some insightful

[38]See Dietz et al., 1998 and Jones and Dunlap, 1992 for a comprehensive review on socio-demographic factors.

perspective on proactive women's participation inenvironmental preservation. They contend that the different socialization and social roles of gender socialization of women to play the role of nurtures, maternity mindset, and caring attitude explains why women value environmental protection more than men. In contrast, Kealy et al. (1990), Swallowet al. (1994), Blocker and Eckberg (1997), and Cameron and Englin (1997) found lower participation of women. Taylor (2000) did not find any gender difference. Marital status is considered as another determinant that might influence the individual's concerns about environmental degradation. Studies have shown a positive effect of married people on a greener environment (Tittle, 1980; Dupont, 2004). It is argued that social networking, more involvement in the community, and the parenthood effect motivates married people to show more concern for the well-being of their kid's future which is associated with a clean environment. In connection to this argument, the study includes the presence of children as one of the determinants to contribute more. A study conducted by Laroche et al. (2001) found a positive impact of having a child and willingness to pay for eco-friendly products. Thus, the study includes marital status and the presence of children in the household as control variables. When compared to other socio-demographic indicators, income is an inconsistent predictor of environmental concern. On the one hand, there is the presumption that wealthy people are more likely to be greener and engage in pro-environmental behavior than poor people (Franzen, 2003; Gelissen, 2007; Kemmelmeier et al., 2002; Franzen and Meyer, 2010; Franzen andVogl, 2013). On the other hand, many studies found a weak correlation between the individual income level and willingness to pay for the environment. For example, Israel and Levinson (2004) found WTP for higher taxes to be positively but statistically insignificantly correlated with income. Similarly, Stumborg et al. (2001) found a positive but weak correlation of individual income with WTP. Moreover, some studies fail to find a more proactive engagement of individuals in richer countries than their poor counterparts. Another study (Ivanova and Tranter, 2004) found income to be a poor predictor of WTP higher taxes for the protection of the environment.

In addition to income, the study also includes the employment status of an individual to test the prediction that the labor force is more likely to be pro-environmental. Participants reported their age (in years) ranging from 18 years to 97

years, highest educational level attained (1 = no formal education to 9 = university-level education), gender coded as (1 = female and 0 = male, self-perceived household income level in the country (1 = lowest group to 10 = highest group), and employment status was recoded as a binary, with categories: 1=currently in the labor force(which includes full-time, part-time, and less than part-time employment, and finally unemployment) and 0= not in the labor force (which includes student status, housewife, helping a family member, retired, and permanently disabled). In addition to the socio-demographic variables, studies also test the effect of religion on environmentalism. The results of the studies varied. Some found the positive contribution of more religious people to environmental protection (for example, Dietz et al., 1998; Owen and Videras, 2007;Cox et al., 2014), while others have found refuting evidence (such asEster and Nas, 1997; Kanagy and Nelsen, 1995; Blocker and Eckberg, 1989). The study constructs a binary variable by merging the first two responses (very important and rather important) as '1'. And '0' for little or not important at all. Besides these, an aspect that has been widely neglected in the literature for so long is social capital. The concept is multidisciplinary and has been used in many disciplines of social sciences. To measure the generalized trust, the study uses a bivariate variable that asks the individual to answer the following question:"In general, would you say that most people can be trusted or that you need to be very cautious in dealing with individuals? Participants chose either "Need to be extremely wary (coded as 0)"or "Most people can be trusted"(coded as 1). This metric has been used as the benchmark for generalized trust (Nannestad, 2008). This permits us to test the impact of the greater the trust of citizens in society, the higher their propensity to contribute to environmental protection. Following the same line of reasoning, the institutional trust measure is included to test the hypothesis that the more people trust their respective institutions, the higher their willingness to contribute to solving environmental issues. The study uses the following question to measure institutional trust: Participants were asked if they trust their respective governments, and we dummy-coded the given responses into a binary variable (1= trust the government and 0 = otherwise).

The direction of this effect, however, is unknown. The provision of public goods falls under the jurisdiction of the government. On the one hand, a lack of trust

in the respective government may exacerbate individuals' concerns about environmental problems. On the other side, people are less likely to contribute to the provision of public goods when they are under the impression that government officials are not doing what they should be doing either.

A handful of empirical studies have used social capital to gauge its impact on attitudes toward the environment, and results remain inconsistent. Some empirical studies support this idea and found that the higher the degree of trust, the higher the willingness to pay to society for environmental protection (Jones et al., 2009; Meyer and Liebe, 2010). In contrast, Halkos and Jones (2011) found a detrimental impact of trust on the WTP for environmental conservation. Finally, following the previous literature, the study includes another potential determinant which is membership in voluntary environmental organizations. Because the provision of public environmental goods through voluntary contribution is one of the primary goals of environmental groups, it is reasonable to anticipate that individuals who participate actively in environmental institutions will have stronger preferences for the protection of the environment. As a result, the following hypothesis is an option to consider: Being a member of voluntary environmental organizations is associated with more strong preferences for protecting the environment. The study recoded the given responses in a binary variable with (1= member, and 0= non-member). Additionally, to test Inglehart's post-materialism theory (Inglehart, 1990, 1995, 1997) and to incorporate the impact of fundamental value orientations on environmentalism, an index of post-materialism is included. The responses to a question about the relative importance of four possible national priorities were used to calculate the "post-materialism"index. These priorities were "Maintaining order in the nation,""Giving the people more say in important decisions,""Fighting rising prices," and "Protecting freedom of speech."The index was named after the fourth of these priorities. Those respondents who selected 1 and 3 as their two priorities were classified as materialists, but those respondents who selected 2 and 4 as their two priorities were scored as post-materialists. Those who chose an example from each category were given a mixed score. Lastly, the study includes settlement size to gauge the impact of urban population on WTP. Specially, the residents living in more populous cities may feel

themselves to be more confronted with environmental problems to a larger extent than those in more sparsely populated cities (Franzen andVogl, 2013).

4.4 Methodology

Given the above-mentioned considerations, the following logit model is set up to test the hypotheses as the dependent variable (environmental concern) is dichotomous.The used logit model estimates the probability of the occurrence of an event rather than the outcome itself. The probability of being pro-environmentalist π_i can be expressed as $\pi_i = \log\left(\frac{P(Y_i=1)}{1-P_i}\right)\pi_i = P(Y_i = 1) = P(Y_i^* > \theta)$ with $Y_i^* the$ latent response. We estimate the following model:

$$Y_{ij}^* = \log\left(\frac{P_i}{1-P_i}\right)\alpha_0 + \alpha_1 Xij + \varepsilon_{ij} \qquad \textbf{(4.1)}$$

where Y_{ij}^* stands for thelog of the environmental concern measure ($P_i = 1$) if the respondent is pro-environmentalist, and 0 otherwise, Xij represents independent side variables of individual iin country j and ε_{ij} represents error term. On the independent side, we use household characteristics, socio-demographic and economic variables as given below:

$$WTP_{ij} = \alpha_0 + \alpha_1(\text{age}) + \alpha_2(\text{Gender}) + \alpha_3(\text{Marital status}) + \alpha_4(\text{Children}) + \alpha_5(\text{Education}) + \alpha_6(\text{Income}) + \alpha_7(\text{Employment status}) + \alpha_8(\text{religion}) + \alpha_9(\text{member organizations}) + \alpha_{10}(\text{general trust}) + \alpha_{11}(\text{govt trust}) + \alpha_{12}(\text{post materialism}) + \alpha_{13}(\text{settlement size}) + \varepsilon_i \qquad \textbf{(4.2)}$$

4.5 Result and Discussion

This section illustrates the empirical findings of the study. In order to find the determinants of willingness to pay, the current study uses pooled data from seven rounds of the WVS (1981-2020) with two different specifications of WTP. The results of the Logit model are reported in Table 1. The first three columns (model 1) display the results using the first proxy/specification of environmental concern (WTP for taxes), and the last three columns (model 2) report the results of the second dependent variable (environment vs. growth). The logit regression for each of the dependent variables is run three times, one with a full(international) sample of countries and then for the subsamples of the developing and developed

world, as we expect the effect of individuals to vary between groups of countries. Therefore, column two and three of each model displays the results obtained for developed and developing countries.

Table 4.1: Logit estimates of the determinants of WTP for environmental protection

	Specification 1/Model 1			**Specification 2 / Model 2**		
VARIABLES	tax_increase	tax_increase	tax_increase	emp_vs_env1	emp_vs_env1	emp_vs_env1
	full sample	Developed	developing	full sample	developed	Developing
Sex	0.037**	0.063**	0.027	0.059***	0.070***	0.036**
	(0.016)	(0.024)	(0.021)	(0.011)	(0.020)	(0.014)
Marital_status1	0.024	-0.009	0.055*	0.117***	-0.082***	0.199***
	(0.024)	(0.036)	(0.032)	(0.017)	(0.031)	(0.021)
Age	-0.006***	-0.003***	-0.006***	0.001**	-0.004***	0.003***
	(5.967e-04)	(8.889e-04)	(8.697e-04)	-4.36E-04	(7.214e-04)	(5.817e-04)
Edu_status	0.051***	0.111***	0.017***	0.055***	0.082***	0.037***
	(0.003)	(0.006)	(0.004)	(0.002)	(0.005)	(0.003)
income1	0.036***	1.999e-04	0.069***	0.011***	0.003	0.014***
	(0.003)	(0.005)	(0.004)	(0.002)	(0.004)	(0.003)
Employed	0.043	0.093*	0.036	0.255***	0.247***	0.226***
	(0.027)	(0.049)	(0.032)	(0.019)	(0.042)	(0.022)
Children	0.013**	0.017*	-0.005	0.003	0.032***	-0.015**
	(0.006)	(0.010)	(0.009)	(0.005)	(0.009)	(0.006)
religon1	0.143***	0.183***	0.003	-0.049***	0.086***	-0.063***
	(0.017)	(0.025)	(0.025)	(0.013)	(0.020)	(0.018)
member_org1	0.306***	0.492***	0.185***	0.127***	0.473***	-8.053e-05
	(0.025)	(0.043)	(0.031)	(0.018)	(0.035)	(0.021)
Trust	0.168***	0.196***	0.117***	0.168***	0.213***	0.089***
	(0.018)	(0.027)	(0.026)	(0.013)	(0.022)	(0.018)
govt_confdnce1	0.405***	0.434***	0.321***	0.144***	0.106***	0.168***
	(0.016)	(0.025)	(0.021)	(0.011)	(0.021)	(0.014)
Materialist	-0.420***	-0.631***	-0.268***	-0.559***	-0.727***	-0.368***

	(0.028)	(0.040)	(0.044)	(0.022)	(0.034)	(0.030)
Mixed	-0.234***	-0.373***	-0.059	-0.455***	-0.509***	-0.310***
	(0.027)	(0.035)	(0.043)	(0.021)	(0.030)	(0.030)
Setlmnt_size	0.005	0.040***	-0.022***	0.017***	0.030***	0.009***
	(0.003)	(0.005)	(0.004)	(0.002)	(0.004)	(0.002)
Constant	0.121**	-0.401***	0.373***	-0.301***	-0.067	-0.428***
	(0.051)	(0.084)	(0.076)	(0.040)	(0.071)	(0.052)
Observations	69,214	29,650	39,564	120,015	41,865	78,150

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

The results of Table 4.1 suggest that the female dummy has positive and statistically significant association in five out of six regressions, indicating that females, on average, are more concerned about the environment in comparison to men. The positive impact of being female on WTP is reported in the previous literature (Franzen and Meyer, 2010; McCright, 2010; Collins et al., 2017; Alavi, 2020; Combes et al., 2018).

The effect of age was found to be negative and statistically significant in the case of the first specification for the full sample as well as sub-samples of countries, which indicates that younger individuals are significantly more likely to agree to give part of their income for the protection of the environment. This result is consistent with the previous studies (Dietz et al., 1998; Torgler and Garcia-Valinas, 2007). In contrast, the result for the second specification shows that older people have strong environmental preferences than younger individuals for the full sample of countries. This positive association holds in the case of developing countries, implying that older individuals prefer the environment over growth than their young counterparts, while in the case of developed countries, the effect of age is negative, implying that younger individuals prefer the environment over growth.

The finding of young people preferring growth over the environment seems plausible in the case of developing countries, where young cohorts aspiring to enter the workforce in the presence of economic constraints faced by the developing countries may be more likely to prefer growth over the environment or /pull attention away from environmental concerns. One's position within the life cycle has implications here. Brulle et al. (2012) found the same result for young individuals in the case of the US

after the financial crunch of 2008, where young people facing unemployment and a weakening economy were less willing to contribute to environmental quality. Tranter and Western (2003) also found similar results.

As expected, education is positively and significantly related to environmental concerns across all six regressions, which means that more educated individuals are more likely to play their role in environmental protection. This result remains robust to the alternative proxies of environmental concern as well as across different sample groups. The result supports the findings of previous studies about education (Olli et al., 2001; Veisten et al., 2004; Marquart-Pyatt, 2012).

The effect of income on willingness to pay for the environment is positive and statistically significant for the whole sample and for the sample of developing countries, which indicates that as income increases, individuals' concern or willingness to contribute to environmental quality increases. The support for the individual income effect can be found in previous literature (e.g., Franzen and Meyer, 2010; Gelissen, 2007; Kemmelmeier et al., 2002).However, the study could not find support for the income effect in the case of the developed world.

In addition, the effect of current employment status is positive and statistically significant in the case of the second specification, which means that employed people are more pro-environmental than unemployed individuals. The finding applies to both developing and developed countries. This result is in line with the previous findings. However, in contrast to the prediction, employment status does not significantly affect the individual's willingness to pay taxes for environmental protection in the case of developing countries and for the whole sample of countries.

The study finds a mixed result for the dummy of married and unmarried in different samples. In the case of developing countries, being married is positively and significantly related to the environmental concern, implying that married people prioritize the environment in the case of developing countries as well as for the whole sample. Previous literature also found a positive impact of married individuals on WTP for the environment (Tittle, 1980; Laroche et al., 2001; Dupont, 2004; Torgler and Garcia-Valinas, 2007). As opposed to the results obtained for the full sample and for developing countries, the group of individuals classified as married show less concern

for the environment than the group classified as unmarried in the case of the developed world. A similar result was reported by Weaver (2002) for UK and Germany, where marital status was negatively related to the environmental concern. However, marital status was not significantly related to the environmental attitude toward paying taxes in whole as well as the sample of developed countries.

With regard to the effect of the presence of children on willingness to contribute to the environment, the study finds that the presence of children positively and significantly affects the individuals' pro-environmental behavior in the case of the full sample. However, the sign of the relationship reverses when we divide the sample into developing and developed countries. The positive relation continues to hold in the case of the developed world, but the presence of children does not positively motivate the individuals of developing countries to contribute to the improvement of the environment.

Turning towards the effects of religion and values previously identified as determinants of pro-environmentalism, the study finds a significant difference between the attitudes of religious and secular individuals and materialistic and post-materialistic individuals. To be precise, the study finds a positive and statistically significant impact of religion on willingness to pay taxes for the environment in the case of developed countries, whereas religion does not play a significant role in explaining the environmental attitudes of developing countries. However, the effect of religion for the second proxy (environment vs. growth) is still positive and significant for developed countries, implying that religion serves as an important determinant for improving the environmental behaviors of individuals. In the case of the other two sample groups, the effect is negative and statistically significant, indicating that religious people are less likely to be pro-environmentalists. The previous literature also found heterogeneous results of religion and environmental concern. On the one hand, some studies found a positive impact of religion in shaping pro-environmental behaviors (for instance, Hand and Van Liere, 1984; Guth et al., 1995; Dietz et al., 1998; Owen and Videras,2007; Cox et al., 2014). On the other side, some found refuting evidence (such as Ester and Nas, 1997;Kanagy and Nelsen, 1995; Blocker and Eckberg, 1989).

Regarding post-materialism, findings reveal that individuals who are high on the materialism side are worried/ likely to be engaged in environmental protection activities,or in other words, post-materialistic individuals are more concerned about the environment than materialistic individuals. This finding is robust across all sample groups and both measures of environmental concern;thus, post-materialistic values arean important determinant of environmental concern in the developing as well as the developed world. Although, the effect of values is stronger, on average, among the individuals of developed countries than their developing counterparts.The finding of the study is in line with the previous literature that found environmentalism as a global phenomenon instead of an issue limited to the richer countries (Dunlap et al., 1993; Gelissen, 2007; Brechin andKempton, 1994).

As hypothesized, trust (both general and institutional trust) is positively and significantly related to the measures of an individual's environmental concern.The finding implies that the more individuals trust other fellow individuals or their respective governments, the stronger their environmental concern/behavior will be. This positive and statistically significant association holds regardless of the measure or the group of countries;thus, trust matters in shaping individuals' environmental attitudes across countries. Our finding is consistent with the previous literature (Jones et al., 2009; Meyer and Liebe, 2010).

The effect of adhesion to an environmental organization is positive and statistically significant in five out of six regressions. The results show that individuals who are associated with environmental organizations do mobilize, or the likelihood of member individuals' willingness to contribute to the environment is higher than those who are not a member of any environmental organization. The result is in support of the previous results found by Combesetal. (2017).

Lastly, the settlement size is positively and significantly related to the environmental concerns in four out of six regressions.

4.6 Conclusion

Environmental degradation/climate change is acknowledged as one of the greatest challenges the world faces today. The scope and repercussions of environmental problems pose a potential threat to the survival of modern society,and

because the issue is closely intertwined with the lifestyles that are prevalent today, it is therefore believed that a better understanding of the factors that can improve individuals' environmental concern can be more effective in implementing policies to balance out the costly struggle between mankind and the environment.

Against this backdrop, it is vital to analyze the potential determinants of an individual's willingness to contribute toenvironmental protection.

Using two different environmental concern measures and seven rounds of world values surveys spanning over four decades, the current study finds that cross-country environmental concern is a multidimensional and complex issue thatcannot be easily explained by any one cause. However, some important findings emerge that provide some basis for future research. Results of the Logit model show that contrary to the post-materialist and affluence hypotheses, this research finds that environmental concern is a global phenomenon and not related to the individuals of rich countries only. In fact, the study fails to find the income effect for the sample of developed countries, while income changes do affect the willingness to pay attitudes in the case of developing countries. Thus, it should not be assumed that individuals of less affluent countries are less concerned about the quality of the environment, at least in regards to "willingness to pay." The study finds variables such as education, general trust, institutional trust, and membership in voluntary organizations to be positively and significantly associated with environmental concern attitudes. These results remain robust and do not change with the use of different proxies of environmental concern or different sample groups. However, the effect of education and trust (both general and institutional) is stronger for developed countries than for developing nations. The positive result of education indicates the need to focus on providing education opportunities, particularly for individuals fromdeveloping countries.In the case of climate change, however, general education is insufficient. For such a scientifically complicated topic, the sort of education also matters; while general education plays a role, specialized education is also essential. One practical solution can be adding more lectures on the dangers of environmental problems, and threats into the school curriculum could enhance environmental concerns.

Our finding of the positive impact of trust (both general and institutional) on individuals' WTP serve as a reminder that people's behaviors, which contribute to environmental concerns, do not occur in a social vacuum. The degree to which individuals put their environmental concerns into action is directly related to how trustworthy they believe other people to be. Hence, efforts to promote environmental concern should keep these dynamics in consideration.

Additionally, the study finds that females, on average, are more inclined toward the improvement of environmental quality;the presence of children promotespro-environmental behavior in developed countries, while the presence of more children is negatively associated with pro-environmental activities in developing countries.

An interesting finding of the study is related to the determinant of age. The study finds that young people in developing counties are willing to pay more taxes for environmental protection but are not willing to prefer growth over employment (second specification of environmental concern). The result indicates the sensitivity of different measures of environmental concern, and environmental concern correlates can vary with the use of different measures of environmental concern.

Employment status is positively and significantly related to the willingness to pay attitudes in all sample groups. As opposed to the hypothesized direction, the study finds that married people in developing countries are pro-environmentalists, while married individuals in developed countries are less willing to contribute to the environment.

Finally, it also should be noted that our limited measures of environmental degradation, world society, and environmental concern should warrant against drawing too firm of a conclusion on the debate over what influences environmental concern. If anything, our results show that the debate is indeed not resolved and that environmental concern is a complex, multidimensional facet of environmentalism that cannot be explained by a single variable or measure. Future research should focus on constructing and refining better indicators and further exploring the relationships between economic affluence, environmental conditions, world society, and other potential macro-level factors in addition to individual-level correlates.

5. CONCLUSION

This thesis study is composed of three separate sustainability studies. The first study focuses on the two different aspects of sustainability for selected South Asian economies. The second study enjoys the benefits of GMM techniques and examines the impact of income inequality on carbon dioxide emissions. Finally, the third study analyzes the drivers of individuals' pro-environmental behavior. The conclusion part of this thesis briefly summarizes the findings and the significant policy implications of these studies.

The purpose of the first studywas to investigate the countries' overall sustainability by using indicators of weak and strong sustainability, with a focus on developing countries in the South Asian region. The study also finds out the critical factors that could lead countries on the trajectory of sustainable development from the perspective of weak sustainability indicators.Results of the study indicate that countries such as Pakistan and India,with the highest share of natural capital in their total wealth, failed to satisfy the criterion of weak sustainability. Other countries in the group, such as Bangladesh, Nepal, and Sri Lanka, manage to have a sustainable path, primarily by growing their human and produced capital in compensation for the rundown of their natural capital stock. These countries follow a modest sustainable trajectory under a weak sustainability criterion. The findings also indicate that none of the South Asian countries was able to pass the criterion of strong sustainability.

The second study carries out an empirical investigation to test the inequality-environment nexus. To empirically analyze the different transmission mechanisms affecting the environment-inequality nexus, the study employs a panel of developing countries around the globe over the period from 1990 to the latest.The panel is then subdivided into two groups of upper and low and lower middle income countries. The study uses the dynamic panel technique of system GMM to tackle the econometrics issues of endogeneity and unobserved country-related effects.

The empirical outcomes confirm this negative correlation between the two, and the results do not change when the aggregate sample is divided into sub-samples. In all three groups, results indicate the existence of a negative relationship between income inequality and CO_2 emissions.

The study findings of a negative elasticity of income inequality on carbon emissions may disappoint those wishing for a win-win outcome of low emissions and low inequality. From the policy perspective, this finding has important implications for policymakers who wish to improve income inequality. On the face of it, it appears that any policy aiming at improving the income gap will contribute to environmental pollution. However, as stated by Scruggs (1998), the existence of a tradeoff does not necessarily imply that income redistribution is undesirable; rather, it highlights the need for more coordinated and balanced policies to get socially desirable outcomes.

The third study provides a comprehensive picture of the potential determinants of an individual's willingness to contribute to environmental protection. Using two different environmental concern measures and seven rounds of world values surveys spanning over four decades, the current study finds that cross-country environmental concern is a multidimensional and complex issue that cannot be easily explained by any one cause. However, some important findings emerge that provide some basis for future research. Results of the Logit model show that contrary to the post-materialist and affluence hypotheses, this research finds that environmental concern is a global phenomenon and not related to the individuals of rich countries only. In fact, the study fails to find the income effect for the sample of developed countries, while income changes do affect the willingness to pay attitudes in the case of developing countries. Thus, it should not be assumed that individuals of less affluent countries are less concerned about the quality of the environment, at least in regards to "willingness to pay." The study finds variables such as education, general trust, institutional trust, and membership in voluntary organizations to be positively and significantly associated with environmental concern attitudes. These results remain robust and do not change with the use of different proxies of environmental concern or different sample groups. These findings provide some useful insights for policymakers that adding more lectures on the dangers of environmental problems and threats into the school curriculum could enhance environmental concerns.

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