THE IMPACT OF ECONOMIC GROWTH, INNOVATION AND POLITICAL INSTITUTIONS ON CARBON DIOXIDE EMISSIONS IN DEVELOPING ECONOMIES

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by

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LIST OF ABBREVIATIONS

AMG	Augmented Mean Group
ARDL	Autoregressive Distributed Lag
BRICS	Brazil, Russia, India, China, and South Africa
CCEMG	Common Correlated Effect Mean Group
CO_2 emissions	Carbon Dioxide emissions
DFE	Dynamic Fixed Effects
EKC	Environmental Kuznets Curve
ERD	Energy Research Development
EU	European Union
FDI	Foreign Direct Investment
FGLS	Feasible Generalized Least Squares
FMOLS	Fully Modified Ordinary Least Squares
GHGs	Greenhouse Gases
GLS	Generalized Least Squares
GMM	Generalized Method of Moments
ICT	Information & Communication Technologies
IPCC	Intergovernmental Panel on Climate Change
LSDV	Least-Squares Dummy Variable
MEA	Middle East & African
MENA	Middle East and North African
MG	Mean Group
MNCs	Multinational Companies
NAFTA	North American Free Trade Agreement
NOx	Nitrogen Dioxide
OECD	The Organisation for Economic Co-operation and Development
OLS	Ordinary Least Squares
PHH	Pollution Haven Hypothesis
PMG	Pooled Mean Group
POLS	Pooled Ordinary Least Squares
RETI	Renewable Energy Technology Innovation
SO_2	Sulfur Dioxide

SSA	Sub-Saharan Africa
SSA	Sub-Saharan African
VECM	Vector Error Correction Model
WDI	World Development Indicators

IMPAK PERTUMBUHAN EKONOMI, INOVASI DAN INSTITUSI POLITIK TERHADAP PELEPASAN KARBON DIOKSIDA DALAM EKONOMI NEGARA MEMBANGUN

ABSTRAK

Perubahan iklim dan pemanasan global telah mendapat perhatian di seluruh dunia kerana kesannya yang meluas. Masalah dalam menyeimbangkan pertumbuhan ekonomi dan kelestarian alam sekitar dengan sumber daya yang terhad adalah isu penting utama bagi pihak kerajaan kerana mereka mungkin terpaksa memilih antara pertumbuhan ekonomi dan peningkatan kualiti alam sekitar. Walau bagaimanapun, kajian lepas mengenai pertumbuhan ekonomi, pelepasan CO_2, dan topik lain yang berkaitan telah mula berkembang sejak kebelakangan ini. Namun, inovasi dan institusi politik adalah antara aspek yang paling diabaikan yang dipercayai mempunyai kesan penting berkaitan dengan pelepasan CO_2 dan kemerosotan persekitaran. Di samping itu, kajian lepas mengenai topik ini masih terhad atau bertentangan. Hasilnya, penyelidikan ini bertujuan untuk menyiasat kesan institusi politik, pertumbuhan ekonomi, aliran masuk FDI, dan inovasi terhadap pelepasan CO_2. Di samping itu, kajian ini bertujuan untuk menentukan apakah keluk Kuznets Persekitaran (EKC) dan Hipotesis Syurga Pencemaran (PHH) berlaku untuk ekonomi sedang membangun terpilih, terutama di bawah pengaruh institusi politik. Kajian ini menggunakan metodologi panel ARDL yang merangkumi kumpulan min (MG), kumpulan min yang dikumpulkan (PMG), dan kesan tetap dinamik (DFE) untuk mencapai anggaran jangka pendek dan jangka panjang. Hasil kajian mengesahkan hipotesis EKC untuk ekonomi sedang membangun dan menghasilkan bukti yang

bertentangan mengenai kewujudan PHH. Selain itu, kajian menunjukkan bahawa inovasi dan penggunaan tenaga mempunyai pengaruh yang baik terhadap pelepasan CO_2. Sebaliknya, kepadatan penduduk dan modal insan didapati mempunyai kaitan negatif dengan pelepasan CO_2. Oleh itu, didapati bahawa Ketika inovasi dan penggunaan tenaga merosakkan alam sekitar, kepadatan penduduk dan modal insan menyumbang kepada peningkatan kualiti alam sekitar di negara-negara membangun antara tahun 1990 dan 2020. Selain itu, kajian juga mendapati bahawa menghapuskan rasuah dapat memberi sumbangan yang baik kepada pengurangan pencemaran secara keseluruhan, peningkatan keberkesanan pemerintah mengakibatkan pengurangan pelepasan CO_2, kestabilan politik yang lebih baik dapat meningkatkan kualiti persekitaran, dan peraturan undang-undang (ROL) mempunyai pengaruh yang baik terhadap pelepasan CO_2. Oleh itu, kajian menyimpulkan bahawa pelaksanaan peraturan anti-rasuah dan polisi alam sekitar menyumbang kepada pengurangan pencemaran dan peningkatan kualiti alam sekitar, dan penguatkuasaan undang-undang yang baik menghasilkan pembangunan ekonomi dan peningkatan pelepasan CO_2. Kajian ini menyumbang kepada kajian empirikal mengenai kesan dan kepentingan institusi politik terhadap pertumbuhan ekonomi, aliran masuk FDI, inovasi, dan pelepasan CO_2 untuk sampel negara sedang membangun yang lebih besar.

THE IMPACT OF ECONOMIC GROWTH, INNOVATION AND POLITICAL INSTITUTIONS ON CARBON DIOXIDE EMISSIONS IN DEVELOPING ECONOMIES

ABSTRACT

Climate change and global warming have received worldwide attention due to their extensive repercussions. The problem of balancing economic growth and environmental sustainability with limited resources is another important obstacle for governments as the governments may be forced to choose between economic growth and enhancement of environmental quality. However, the literature on economic growth, CO_2 emissions, and other related topics has expanded in recent years. Yet, innovation and political institutions are among the most overlooked aspects that have an important impact in relation to CO_2 emissions and environmental degradation. In addition, the literature on these topics is either limited or contradictory. As a result, this research aimed to investigate the impact of political institutions, economic growth, FDI inflows, and innovation on CO_2 emissions. In addition, the study sought to determine if the Environmental Kuznets Curve (EKC) and pollution haven hypothesis (PHH) hold true for selected developing economies, particularly under the effect of the political institution. This study employed panel ARDL methodology which included mean group (MG), pool mean group (PMG), and dynamic fixed effects (DFE) to achieve short-run and long-run estimates. The study's outcomes confirmed the EKC hypothesis for developing economies and produced conflicting proof of PHH's existence. Additionally, the study revealed that innovation and energy consumption had a beneficial influence on CO_2 emissions. In contrast,

population density and human capital were discovered to have negative connection with CO_2 emissions. Thus, it is found that while innovation and energy consumption degrade the environment, population density and human capital contribute to a boost in environmental quality in developing economies between 1990 and 2020. Additionally, study also found that eliminating corruption may contribute favourably to overall pollution reduction, increased government effectiveness results in CO_2 emission reductions, greater political stability translates in an improvement in environmental quality, and rule of law (ROL) has a beneficial influence on CO_2 emissions. Thus, study concluded that executing robust anti-corruption and governance regulations contributes to pollution reduction and environmental quality improvement, and greater rule of law results in economic development and increased CO_2 emissions. The study makes a substantial contribution to the empirical literature on the effects and significance of political institutions on economic growth, FDI inflows, innovation, and CO_2 emissions for a larger sample of developing nations.

CHAPTER 1

INTRODUCTION

1.1   Introduction

Climate change is among the most critical environmental issues confronting the world in the 21st century. Greenhouse gases (GHGs) are the major cause of environmental pollution, climate change, and global warming (NASA, 2018a). Climate change is not the only threat to human beings but also all other living species. Some of the consequences of climate change are floods and droughts, extreme rainfalls, rising levels of oceans, rising temperatures, and melting of glaciers. Melting of glaciers has greatly affected the ecosystem of freshwater and posed a great threat to hydropower, agriculture, and sanitation of people, thus climate change affects the survival of human beings (NASA, 2018b). According to the Intergovernmental Panel on Climate Change (IPCC), there will be a shortage of food and water for millions of people. It was also predicted that great risk of quality of life will be faced by the people due to climate change. In particular, developing countries were mainly identified to face such risks since the lack of financial, technological, and social resources make them the most vulnerable regions to climate change (IPCC, 2007). To be specific, climate change has badly hit the earth and will continue to hit if the safety and mitigation measures are not taken immediately.

Moreover, a dramatic rise in worldwide emissions of greenhouse gases (GHGs) caused by human activities over the past several decades has resulted in unparalleled environmental degradation. Environmental degradation is the deterioration of the environment caused by the depletion of resources including air, water, and soil; the destruction of ecosystems; and the loss of species. It is defined as any alteration or

disruption of the environment that is deemed harmful or unwanted (Chhabra et al., 2023). Environmental degradation, however, comes in a variety of forms, one of which is land and soil degradation, which is the degradation of soil quality caused by bad agricultural techniques, excessive use of fertilisers and pesticides, and landfill leaks. Second is water degradation, which is the pollution of water caused by rubbish thrown in seas, unlawful dumping, and the discharge of significant quantities of industrial waste into surrounding rivers or lakes. Degradation of the atmosphere, also known as atmospheric degradation, is the third form of environmental degradation. This type of degradation includes air worsening, particle pollution, and the loss of the ozone layer. Other types of pollution such as noise and light pollution are also environmental degradation.

Furthermore, the fast rise in CO_2, one of the primary greenhouse gases, has attracted the curiosity of a significant number of researchers and industry professionals all over the world. Since the 1900s, the burning of coal and other fossil fuels has substantially increased the rate at which CO_2 emissions are produced around the globe in order to satisfy the requirements of energy consumption (Chhabra et al., 2023). The total worldwide CO_2 emissions have increased dramatically in the last three decades, increasing by roughly 63.91 percent until 2019 (IEA, 2022). In addition, the COVID-19 crisis has led to an even greater increase in CO_2 emissions by compelling power plants to use coal and other fossil fuels at maximum capacity in order to satisfy the elevated energy consumption requirements and return the rate of economic growth to where it was before the pandemic. This has led to a significant rise in CO_2 emissions, which has resulted in the highest increase ever recorded in the annals of global history, totalling more than 2 billion tonnes (IEA, 2022; Chhabra et al., 2023).

This environmental problem has become a serious concern around the world and has received enormous attention from scientists, environmentalists, policy makers, governments, and heads of states. In addition to the above environmental problem, other critical challenge for the governments is to realise higher economic growth, economic stability, and sustainable development.

To comprehend why it is difficult to simultaneously enhance environmental quality and achieve sustainable development, we must delve deeper into the roots. We discover that achieving sustainable development necessitates industries engaging in economic production, which necessitates energy consumption and the use of fossil fuels. This process of economic progress has depleted natural resources, and has released a massive amount of toxic emissions (e.g. CO_2, SO_2, NO_x) into the atmosphere making the climate warmer than before (Kang et al., 2016), thus lead to trade-off between environmental quality improvement and achievement of economic development.

However, above issue can differ for developed nations, emerging and developing economies[1]. In general, developing economies are often seen in dire need of FDI inflows and higher rates of economic growth to manage economic issues such as lowering their fiscal deficits, raising living standards and providing employment. To achieve the desired level of economic growth and to attract FDI they take possible

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[1] The emerging markets and developing economics are classified and selected based on the World Economic Outlook 2009 report by International Monetary Fund (IMF). The IMF's criteria were based on "the degree of integration in the global financial system, export diversification, and per capita income." a precise difference between developing and emerging markets economies is that the economies having a less developed base for industries, lower standards of living, poor status in the global financial arena, and dependency on strong economies for economic development are developing countries while emerging markets economies are the countries having great economic growth, relatively better position in the global financial arena, and just stepped up from conventional mediums of sustenance.

measures to chase growth standards and attract possibly maximum amount of FDI. Yet, to make this possible the growth industries are given incentives to produce at a faster pace resulting in hasty production, this action is detrimental to the environment i.e., quality of the environment is being sacrificed in a way to economic growth, this conforms to the 1991 theory proposed by Grossman and Kruger, according to which economic growth initially degrades environmental quality. However, after a certain level of development is reached, environmental quality starts to improve. This concept is renowned as the Environmental Kuznets Curve (EKC).

Moreover, FDI is also an important source for economic growth, prosperity, and creating jobs, thus developing economies also set their regulations in a possible flexible manner so that FDI may be attracted, these regulations also involve pollution-related taxes, and making them flexible is a good way of providing safe heavens to pollution-intensive firms abroad. Furthermore, pollution-intensive firms transfer their plants to countries with flexible regulations and start producing and emitting pollution and degrading the environment, what is renowned as the pollution haven hypothesis (PHH) was firstly studied by (Copeland and Taylor, 1994). Hence, it may be said that for developing economies to chase FDI as well as economic growth may compromise environmental quality, thus leading to environment degradation.

Similarly, this research tries to discover the association between economic growth, FDI, and environmental degradation. But, since there are also other factors which impact these relationships i.e., innovation (technology) and political institutions, this study also includes these two factors in part of the analysis and discovers pattern and relationships among economic growth, FDI, innovation, environmental degradation and role of political institution.

In addition to economic growth and FDI, effective adaption of innovative technologies may also work as catalyst for mitigation of carbon emissions and may reshape the strategies related to carbon abatement. Technology works as a crucial factor by which the environmental quality is affected by economic growth (Grossman and Krueger, 1991). Technological innovations are important to economic growth and the production process (Çalışkanaa and Kesici, 2015). Since innovations may lead to new ideas that are energy efficient and may help firms to produce at lower costs and lower pollution. Technological advancements may have a substantial influence on the relationships between economic players and entities upheld by Schumpeter[2]'s "Creative Destruction" theory. The idea was the destruction of weak sectors and the emerging of new sectors with new technologies and development in the economy. Likewise, these technological innovations may have bad or beneficial effects on the environment, therefore it is rational to assert that technological innovation alters structures, hence influencing the environment.

Similarly, institutions are of great importance since they are human devised constraints necessary for economic, social, and political interactions. The EKC hypothesis does not entirely depend on income level rather other factors are also significantly important for this relationship. These include institutional and demographic variables, since their improvements increase earnings, allow residents to demonstrate their willingness to pay for improved environmental quality, and influence the political system (Abid, 2016). Equally, FDI inflows and innovations in the economies are also affected by these demographical and institutional factors.

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[2] In 1942, Joseph Schumpeter coined the term 'Creative Destruction' and described it as "process of industrial mutation that incessantly revolutionizes the economic structure from within, incessantly destroying the old one, incessantly creating a new one." (Refer to Schumpeter, 1942).

Besides institutions' impact on economic growth, FDI inflows, and environmental degradation, institutions are also considered the main drivers for innovations (Aghion and Howitt, 1992) and are found to have a significant impact on innovations by creating an innovative environment by providing incentives. Quality of environment can be influenced by innovation and political institutions such as poor the quality of political institutions may make environmental regulation weaker by setting bias in the adaption process and implementation of regulations (Welsch, 2004).

In addition to affecting innovation and environmental quality, political institutions are crucial for association between environmental quality and economic growth. Firstly, FDI can be attracted if political institutions are of high quality and enhance both performances i.e., economic and environmental (Frankel and Romer, 1999). Secondly, the above procedure can be reversed if there is a poorer quality of political institutions, moreover, economic growth may decline, and significant damage may occur to the environment by environmental externalities (Lopez and Mitra, 2000; Welsch, 2004). Thus, it will be very interesting and useful to examine linkages and connections between economic growth, FDI inflows, innovation, and environmental degradation in presence of institutional factors for developing economies since they emit pollution to a great extent and have weak institutional regulations. This research considers various indicators of political institutions such as control of corruption (CC), political stability (PS), government effectiveness (GE), regulatory quality (RQ), and rule of law (ROL).

However, the system of government can also influence the environmental quality such as rule of law (ROL) is single among many elements of this broader system of government, which is responsible for ensuring property rights, stability and correct functioning of judicial system, etc. robust rule of law (ROL) or legal system may

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decrease the probability of failure of markets, enhance economic activity, minimize the lasting impacts of market failures, and plays a significant role in compliance, thus, the existence of strong rule of law leads to better compliance which helps in the enforcement of CO_2 mitigation policies and laws. Therefore, rule of law plays a significant role in compliance, thus, the existence of rule of law leads to better compliance which helps in the enforcement of CO_2 mitigation policies and laws. The clear and well design rules may help firms to comply easily without any hesitance with the control procedures of CO_2 emissions. Otherwise, if rules are weak and there is poor enforcement of laws, firms may evade complying with rules and hence compliance of rules can be complex to enforce (Azmat Gani, 2012). Thus, the high quality of political institutions is found to promote fruitful cooperation among market players (Olson, 1996).

Similarly, corruption may directly or indirectly have impact on the levels of pollution, the direct impact of corruption implies that as higher corruption leads to higher pollution while the indirect effect is income dependent and could either be positive or negative. Overall, the direct effect is found to be dominated the indirect effect leading to the conclusion that corruption increases pollution, and thus causes environmental degradation.

Moreover, it is also recommended that developing countries must focus on the reduction of corruption to enhance economic and environmental performance as the impact of corruption was high in low-income countries (Welsch, 2004). Therefore, institutional frameworks have a significant impact on pollution by both direct and indirect ways i.e., directly by the institutional quality and indirectly through economic growth and trade openness. Thus, institutional frameworks significantly influence pollution in both ways directly by the institutional quality and indirectly through trade

openness and economic growth and control of corruption is found to be negatively related to CO_2 emission (Abid, 2016), also corruption remarkably impact environmental policy (Pellegrini and Gerlagh, 2006), several researchers have discovered a considerable influence of corruption control on economic growth and environmental quality, this indicates that institutional background should be focused to target a lessening in CO_2 emissions and improvements in economic growth. Nevertheless, developing countries generally have poor and weak political and institutional records in terms of protecting the environments. For a nation to prosper economically, it must first have strong institutions thus, quality of institutions is of a significant importance since the prosperity and progress of every nation are directly tied to the quality of its institutions.

There are a number of potential ways in which the quality of regulations might affect environmental quality (Esty and Porter, 2005). Quality of regulation can have a dampening effect on CO_2 emissions and on inclusive human development (Asongu and Odhiambo, 2019). However, regulatory quality can have a beneficial influence on CO_2 emissions (Abid, 2016), as well as a considerable detrimental influence on CO_2 emissions (Danish et al., 2019). Regulatory quality (RQ) may influence environmental quality while strict regulations on the entrance of firms into markets are related to informal economies, more corruption, and less democratic governments (Djankov and Hoekman, 2000; Esty and Porter, 2005).

However, government effectiveness may also play a substantial role in sustaining air pollution levels, since effective governments may gain the trust of manufacturers and enforce environmental regulations. Thus, government efficiency may be useful in maintaining CO_2 emissions (Varoudakis et al., 2007). Government effectiveness negatively impacts CO_2 emissions that is an improvement in government effectiveness

reduces air pollution and improves environmental quality, it was also shown that countries with highly successful governments (higher government effectiveness) had a considerable decrease in CO_2 emissions. (Abid, 2016; Wawrzyniak and Doryń, 2020). Therefore, the government effectiveness alters the CO_2 emission-economic growth association.

Political stability is crucial for attracting FDI inflows, generating economic growth, and protecting the environment. Moreover, improved political stability is strongly related to reductions in CO_2 emissions and also found to have flattened income-CO_2 emissions curve (Galinato et al., 2012; Abid, 2016). It was also empirically proved that in the long run improved political stability reduced conflicts, ecological footprints, and the environmental degradation (Al-Mulali and Ozturk, 2015). Moreover, if the government regime is weak and vulnerable, it may not be possible for them to enforce sound governing institutions, thus political stability also matters in effectively controlling the emissions (Alesina and Perotti, 1996; Svensson, 1998). Whereas, political instability may also influence the rule of law, that is, ineffective governance and regulations may be the outcome of the state's weak institutions, and this system further weakens by bribery. These overall forces maybe act as a hurdle in the way to curbing CO_2 emissions (Fredriksson et al., 2005).

To put it in simpler words, an institutions have been one of the key drivers in the effort to reduce carbon emissions as well as the economic and social effects of such emissions. Higher-quality institutions promote renewable energy, which helps in the development of green technologies and encourages knowledge spill overs, ultimately resulting in a reduction in environmental degradation as a result of these institutions' stringent and effective policy choices regarding the environment. The empirical

research demonstrates that efficient institutions develop policies that minimise CO_2 emissions and promote a cleaner environment (Wawrzyniak and Doryń, 2020; Haldar and Sethi 2020; Khan and Rana 2021). Poor institutional quality, exemplified by corruption, lawlessness, and ongoing internal and external disputes, however, exacerbates environmental degradation (Abid 2016; Azam et al. 2020; Teng et al. 2020). This hinders the transformation of production activities away from renewable resources and impedes the achievement of sustainable development. It not only affects environmental quality, but also raises economic and environmental expenses. Ineffective energy planning and policy formulation undermine institutions and make it difficult to address growing carbon emissions. This raises the probability of political instability and inefficiency, both of which result in low environmental rules. Thus, it is not incorrect to argue that, in developing nations, the influence of institutional quality in relation to CO_2 emissions remains uncertain. This makes it difficult to determine if strong institutions lead to reduced CO_2 emissions.

Institutions are associated to not only CO_2 emissions and environmental degradation, but also FDI, economic growth, and innovation. A study by Huynh and Hoang (2018) found that FDI inflows lead to an increase in the levels of air pollution while the improvements in institutional quality help this effect to be reduced until the threshold of institutional quality. However, the study also discovered that after achieving that threshold for institutional quality, the effect of FDI inflows reversed and FDI inflows led to a reduction in air pollution. Overall, the institutions may have a major role in economic growth, FDI, innovation, and environmental degradation nexus as a study on the moderating role of institutional quality with the addition of role of technological innovation on FDI inflows-CO_2 emissions nexus conducted by Bakhsh et al. (2021) concluded that FDI inflows positively impact CO_2 emissions while

institutional quality and technological innovation proved to be crucial moderators for FDI inflows-CO_2 emission relationship. The moderation of institutional quality and technological was found to lessening CO_2 emissions.

To summarize, the challenge for governments are preserving environmental quality and achieving a sustainable development but is it possible with scarce resources to address both concerns at a same time? The real problem that countries with limited resources may face can be a trade-off between expansion of economy and improvement of environmental quality. To put it in a very straight forward way, the issue is, can we achieve higher economic growth and attract FDI inflows without giving up on the quality of environment? Or do we need to pay cost in terms of environmental degradation while achieving higher economic growth and attracting FDI inflows? Is it possible to achieve higher economic growth and attract larger quantities of FDI inflows and improvement in environmental quality simultaneously? If yes, how can we? Where do we need to pay attention, on innovations? Or on political institutions?

The answers to these questions may be difficult but not impossible and since there are so many factors that can have a vital role in answering above questions, exploring and considering all those factors will probably be out of scope of this research. So this research only focuses on development, governance, and environmental factors while attempting to find answers to the above questions.

1.2 Innovation, FDI inflows, and Economic Growth insights of Developing Economies

1.2.1   Innovation insights in developing economies

In general, developing economies heavily rely on the sector such as agriculture, forestry, and tourism, but lack in technological advancements (innovations), financial, and social resources makes these developing economies the most vulnerable to climate change. Developing economies may expect an economic growth drop of 1.3 percent for every 1-degree centigrade rise in temperature (Bak et al., 2017), as a result, encouraging climate-resilient and low-carbon infrastructure are of vital significance for achieving inclusive economic growth, climate goals, and sustainable development (Bak et al., 2017).

Moreover, innovative technologies can aid in reducing carbon emissions through energy conservation (Lin and Zhu, 2019). The eco-friendly innovations are getting attentions worldwide so that the governments and organizations across the globe have been prioritizing and putting pressure on various stakeholders to invest in eco-friendly, climate-resilient and low-carbon infrastructure, and innovations (Darnall and Carmin, 2005; Cimato and Mullan, 2010; Moratis, 2018). Particularly, they are doing high expenditures on innovative technologies and innovative capabilities to achieve economic power at minimal or zero harm to the environmental quality (Aghion and Howitt, 1992; Pegkas et al., 2019). However, the transformational role of technologies is being acknowledged in dealing with socio-economic, and environmental issues by the developing economies (Li and Wang 2017; Chen and Lei, 2018). This recognition has led to a persistent struggle to update old technologies to new and innovative technologies (Binz et al., 2012).

The innovation is measured by various proxies in the empirical literature such as Patent (patent application by resident) per capita, R&D Patent (patent application by a

non-resident) per capita, Research and Development per capita (Mensah et al., 2018; Khattak et al., 2020), innovation per capita (Santra, 2017), and number of environmental patent applications filed (Hashmi and Alam, 2019).

However, this study will take patents applications by residents as a proxy for innovation to discover innovation impact on environmental degradation. The patent applications filed by residents have considerably increased for the last three decades which can be seen from figure 1.1 which presents patent applications, by residents as a proxy for innovation for the world from 1985 to 2019.
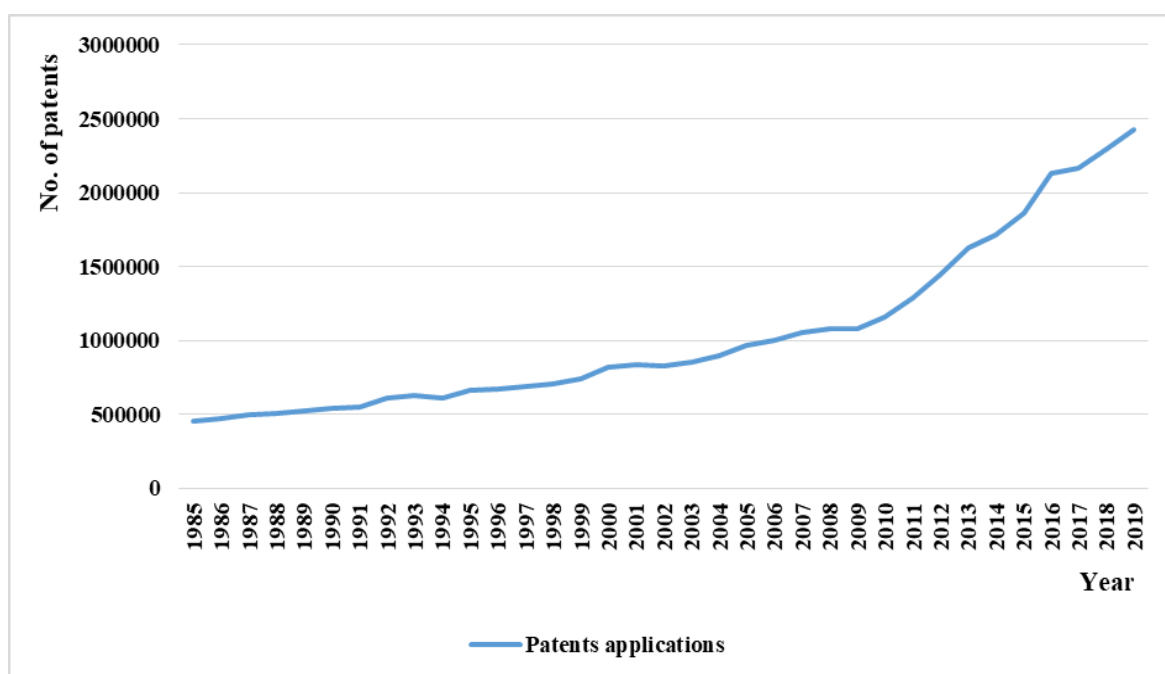

Figure 1.1   Innovation trend by the World

Source: World Development Indicators (WDI) database of World Bank

Figure 1.1 shows the trend for patent applications filed by residents overtime over the entire world. As shown in the figure that innovation around the world has considerably increased over time such as in year 2000 the number of patent

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applications was 823135, and it reached to number 2294847 by the year 2018. Therefore, the question posed by this study is if the innovation reduces environmental pollutants and enhances environmental quality. However, figure 1.1 is for the world which also involved the developed economies, but this study aims for developing economies, so figure 1.2 shows the trend of innovation in developing economies.
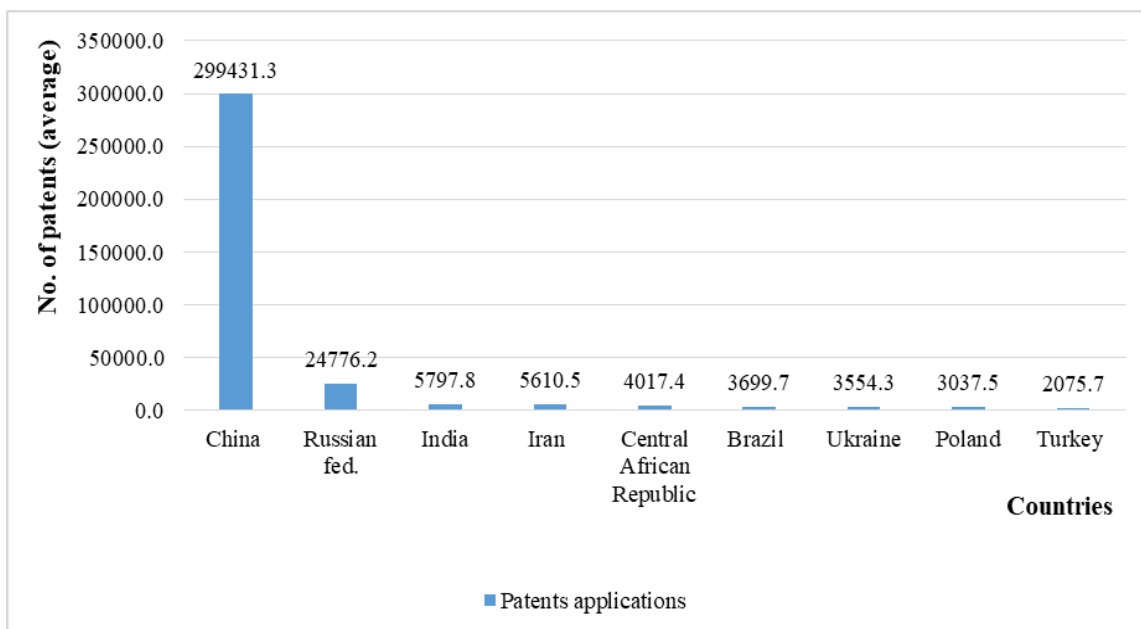
Figure 1.2   Innovation trend by selected developing economies

Source: World Development Indicators (WDI) database of World Bank

Figure 1.2 shows the applications for patents, filed by residents (innovations) in developing economies. The figure displays the bars for the top nine countries, the bars have been made on by taking arithmetic mean (average) values of patents applications for each country over the period 1990-2019. China tops the list of patent applications and on average stands at 29941.3 patents applications, followed by Russian Federation, which on average stands at 24776.2 patents applications, India, Iran, and other countries as shown in the figure. Countries that have filed on average less than 2000 patent applications are not included in figure 1.2.

1.2.2   Economic growth and FDI insights in developing economies

Both increased economic growth and FDI contribute either directly or indirectly to a degradation of the natural environment in some way. The association between economic expansion and environmental degradation leads to the EKC theory, which suggests an inverted U-shaped connection between economic growth and environmental degradation. This study seeks to determine the empirical connection between economic growth and environmental degradation and to verify EKC presence for 49 developing economies. Yet, it will be convenient to witness the trends of economic growth of the world and developing economies. The economic growth trend for the world from 1985 to 2019 is presented in figure 1.3. The GDP per capita is used as the measure to quantify economic growth in this study.
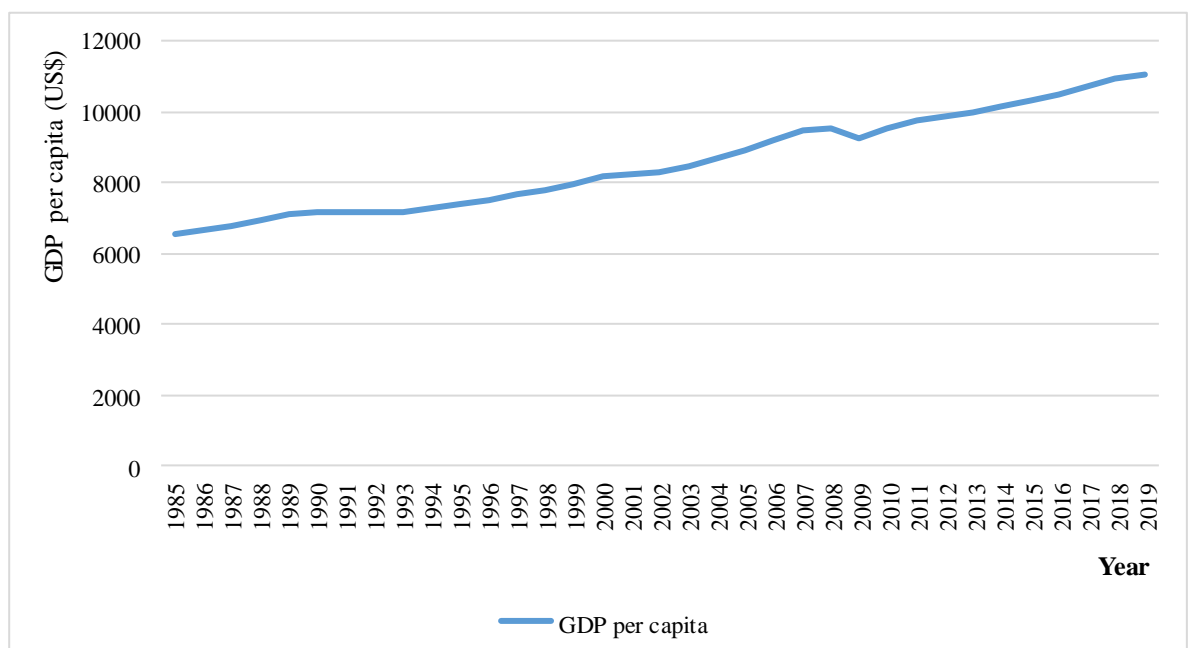

Figure 1.3   GDP per capita by World

Source: World Development Indicators (WDI) database of World Bank

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Figure 1.3 shows the economic growth (measured by GDP per capita) for the world from 1985 to 2019. The economic growth of the world in 1985 was 6543.745 and raised to 11069.79 in 2019. This increasing trend in economic growth has occurred due to many factors such as consumption of energy and FDI inflows and more. Since figure 1.3 is for the economic growth of the world and this study aims for developing economies, it is better to look graphically at the economic growth of such economies. Thus, figure 1.4 presents arithmetic mean average of GDP per capita (Constant 2010 US$) for selected developing economies.
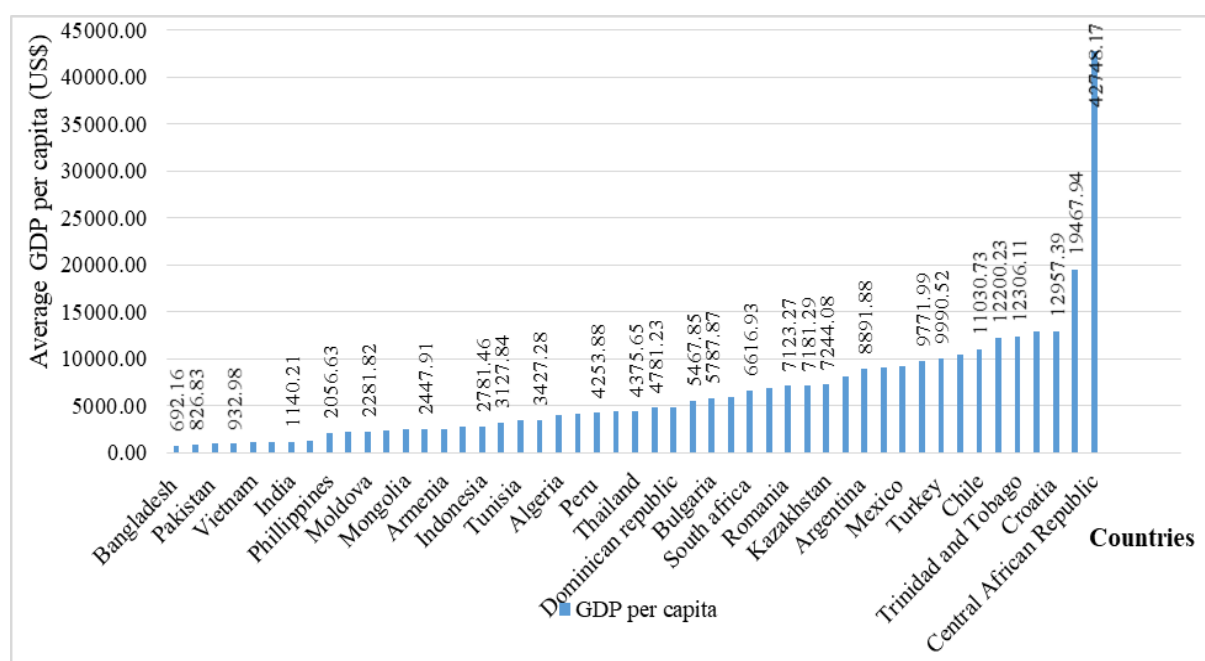

Figure 1.4   GDP per capita by selected developing economies

Source: World Development Indicators (WDI) database of World Bank

Figure 1.4 shows an average of GDP per capita for developing economies over 1990-2019. The graph only shows the developing economies that have more than 6000 average GDP per capita. Central African Republic has the highest average GDP per

capita of 42748.17, while Saudi Arabia and Croatia have an average GDP per capita of 19467.94 and 12957.39 respectively.

As mentioned earlier, FDI inflows may either improve the environmental quality by transferring eco-friendly technologies or harms the environment quality due to the shifting of pollution-intensive plants and industries. The latter statement leads us to the earlier mentioned pollution haven hypothesis (PHH) that is FDI inflows harm the environmental quality and causes environmental degradation. This study also attempts to demonstrate empirically the connection between FDI inflows and environmental quality, thus, the empirical answer to this question will give us evidence of whether to support or reject the existence of PHH for developing economies. However, FDI net inflows (% of GDP) trends in the world have been increased as shown in figure 1.5.
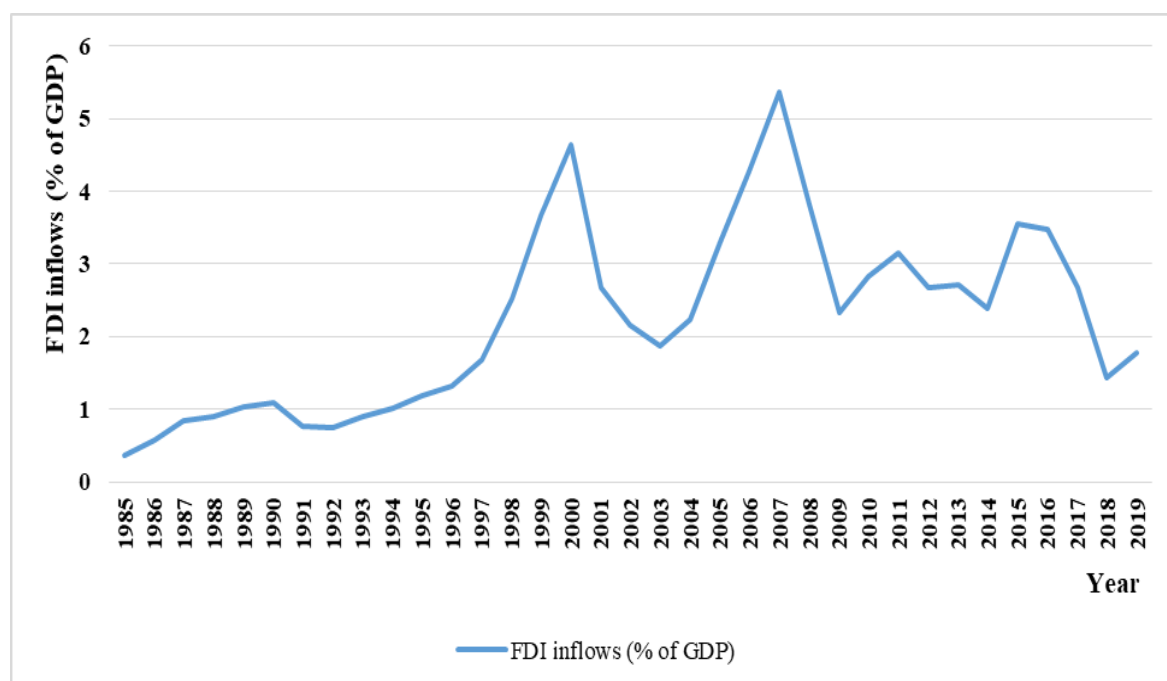

Figure 1.5   FDI net inflows by World

Source: World Development Indicators (WDI) database of World Bank

Figure 1.5 shows FDI net inflows in the % of GDP by the world. FDI net inflows trend has fluctuations and has remained volatile such as FDI net inflows in the world grew 1.69% of GDP in 1997 to 4.64% of GDP in 2000 followed by downfall to 1.87%

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of GDP in 2003 to rise again 5.32% of GDP in 2007 and so on so forth. However, for developing economies FDI inflows trend, the arithmetic mean averages of countries FDI net inflows are presented in figure 1.6.
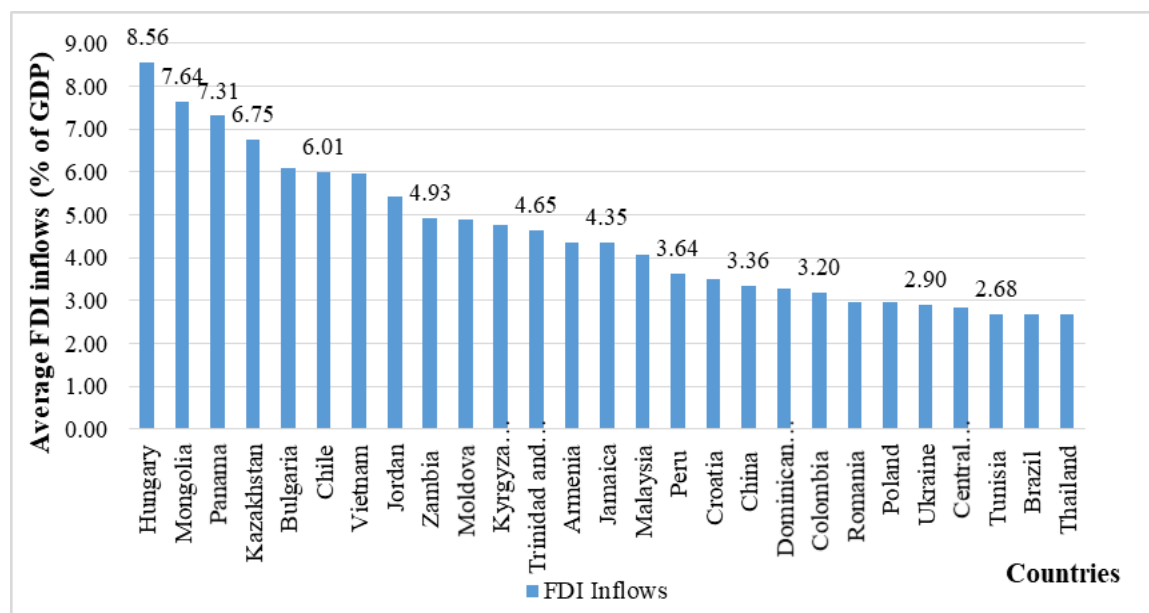
Figure 1.6   FDI net inflows by selected developing economies

Source: World Development Indicators (WDI) database of World Bank

Figure 1.6 shows arithmetic mean averages of FDI net inflows (measured in percentage of GDP) in developing economies, as shown in figure 1.6 Hungary has the highest FDI net inflows on the average of 8.56% of GDP, followed by Mongolia and Panama with average FDI net inflows of 7.65% and 7.31% respectively, rest of countries are shown in the figure with respective values. The figure 1.6 only include those countries whose average FDI inflows are more than 2.5%.

1.3 Environmental status in developing economies

Environmental status is of significant concern in developing economies, particularly in lower-income economies where environmental quality is not been considered a major threat rather than poverty, unemployment, and other basic issues. A research report by the Intergovernmental Panel on Climate Change (IPCC) found that climate change owing to rising temperatures is connected with both long- and medium-term economic costs, which appear to be greater for developing nations (IPCC, 2019). Moreover, rising temperatures have more negative impacts on the economic growth of emerging economies relative to developed nations, as stated by the Massachusetts Institute of Technology report. The impacts are more adverse for developing economies because of their dependence on climatic conditions sensitive sectors such as forestry and tourism (Wade and Jennings, 2015).

However, environmental degradation is a global issue having widespread impacts at a global level regardless of the income of a country. There are numerous elements which are responsible for environmental degradation, among which main contributors are greenhouse gases (GHGs), which mix into the air in the atmosphere and cause air pollution. Thus, deteriorating environmental quality. The most abundant GHGs are nitrous oxide (N_2O), methane (CH_4), and carbon dioxide (CO_2). Moreover, combustion of fossil fuels releases CO_2, whereas production and transportation of gas, oil, and coal release CH_4, and N_2O is emitted by agricultural and industrial processes. Fluorinated gases, commonly known as gases with a high global warming potential, are generated by industrial activities (IPCC, 2014).

1.3.1 Carbon Dioxide (CO_2) emissions

According to IPCC report, the CO_2 emission is responsible for almost 76% of world GHGs. Human activities and the combustion of fossil fuels emit CO_2 gas. The emission of CO_2 into the atmosphere is among the primary contributors to climate change and global warming (IPCC, 2014). The global trend of CO_2 emissions has been increased and continues to increase as shown in figure 1.7.
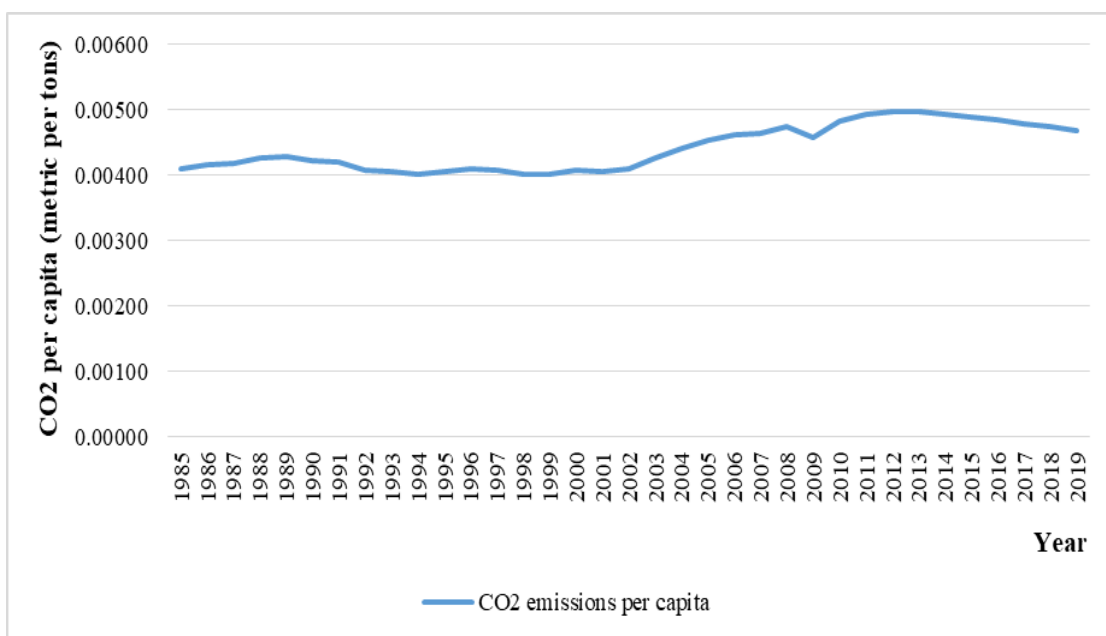
Figure 1.7 CO_2 emissions trend by World

Source: World Development Indicators (WDI) database of World Bank

Figure 1.7 presents CO_2 emissions measured in metric tons per capita for the world from 1985 to 2019. It can be seen from the figure that overall carbon emissions have slightly increased over time, causing air pollution and thus global warming and climate change. As shown in the figure, CO_2 emissions were 0.0041 metric tons per capita in 1985, and then rose to 0.0046 metric tons per capita in 2007, and further rose in 2011 to 0.0049 metric tons per capita, this is shown by the upward trend in the figure 1.7.

Nevertheless, the developed countries also contribute to GHGs, but since we are to study developing economies, we should also look at the CO_2 emissions trends in developing economies.
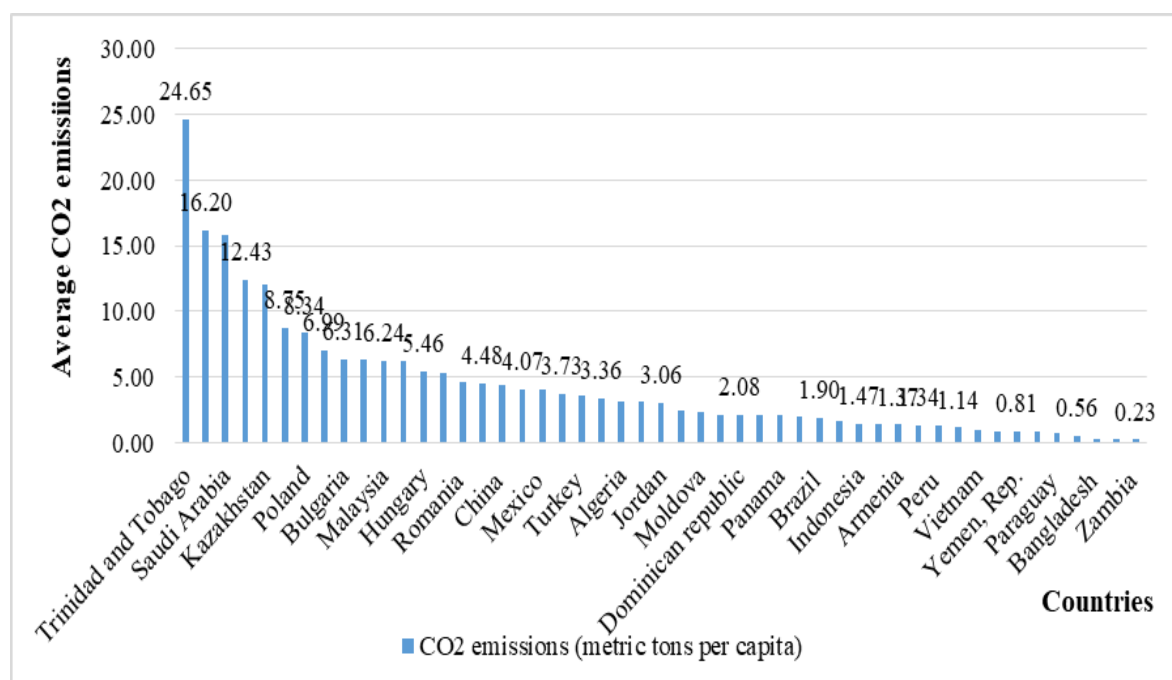
Figure 1.8 CO_2 emissions by selected developing economies

Source: World Development Indicators (WDI) database of World Bank

Figure 1.8 shows an average for period 1990-2019 for CO_2 emissions for selected developing economies. As in shown in figure Trinidad and Tobago has the highest average of CO_2 emissions of 24.65 metric tons per capita for period 1990-2019, followed by Central African Republic, Saudi Arabia, and Russian Federation with an averaged CO_2 emissions of 16.20 metric tons per capita, 15.84 metric tons per capita, and 12.43 metric tons per capita respectively.

1.4 Problem of Statement

There is a serious growing concern about global warming and climate change around the globe that has received enormous attention from scientists, environmentalists, policymakers, governments, and heads of state due to its widespread consequences in the form of floods, droughts, extreme rainfalls, rising levels of oceans, rising temperatures, and melting of glaciers etc. and if safety precautions and climate change mitigation strategies are not implemented immediately, the effects of global warming and climate change will continue to be felt around the globe. Moreover, developing countries were mainly identified to face such risks since the lack of financial, technological, and social resources makes them the most vulnerable areas and primary targets of climate change.

In addition to this environmental problem, another critical challenge for governments is to attain higher economic growth, economic stability, and sustainable development since it is not possible with scarce resources to address both concerns at the same time and the countries with limited resources may have to choose between the expansion of economy and improvement of environmental quality. So, these fragile developing nations have to choose between improving environmental quality and economic growth.

Similarly, developing countries also need to attract FDI inflows from abroad since FDI inflows are an important source for economic growth, prosperity, and creating jobs, thus developing economies also set their regulations in a possible flexible manner so that FDI may be attracted, these regulations also involve pollution-related taxes, and making them flexible is a good way of providing safe heavens to pollution-intensive firms abroad. Thus, developing economies to chase FDI as well as economic

growth may compromise environmental quality, consequently, leading to environmental degradation in the host countries.

Therefore, this study is to evaluate the effect of economic growth as well as FDI inflows on environmental degradation to determine where developing economies should concentrate their resources and pay more attention, i.e. increasing environmental quality, accelerating economic growth, or targeting FDI inflows. More specifically, the question this study asks is how economic growth and FDI inflows impact environmental degradation in developing economies. Likewise, innovation effective adaption of innovative technologies may also work as a catalyst for the mitigation of carbon emissions and may reshape the strategies related to carbon abatement since innovations may lead to new ideas that are energy efficient and may help firms to produce at lower costs and lower pollution, thus, innovations are also important to economic growth and the production process.

Thus, innovations may have good or bad effects on the environment, therefore it is rational to assert that technological innovation alters structures, hence influencing the environment. As a result, the question posed by this study is if the innovation reduces or increases environmental pollutants and enhances environmental quality or degrades it.

Another important aspect of this study is the role of political institutions in economic growth, innovation, and CO_2 emissions relationship, as political institutions considerably influence economic growth and environmental quality because political reforms raise revenues, permit citizens to indicate their willingness to pay for enhanced environmental quality, and shape the political process. Moreover, political institutions are also regarded as primary drivers of innovation, as they foster an inventive atmosphere through the provision of incentives. The quality of the

environment can be altered by innovation and political institutions, which can weaken environmental control by introducing bias into the adaptation process and implementation of rules.

Apart from their influence on innovation and environmental quality, political institutions have a critical role in attracting FDI inflows, stimulating economic growth, and enhancing environmental performance. Firstly, FDI can be attracted if political institutions are of high quality, accelerating economic growth and environmental performance. Secondly, the preceding method can be reversed if political institutions are of lower quality; additionally, economic growth may slow, and considerable environmental harm may result from environmental externalities. Also, political institutions influence policy-making decisions regarding chasing economic growth and targeting environmental degradation with various tools. Thus, this study also investigates the role of political institutions in economic growth, innovation, and environmental degradation nexus.

Therefore, it will be very interesting and useful to examine linkages and connections between economic growth, FDI inflows, innovation, and environmental degradation in presence of political institutions for developing economies since they emit pollution to a great extent and have weak institutional regulations. As a result, this study tries to discover the role of political institutions in boosting economic growth, attracting FDI inflows, encouraging innovation, and improving environmental quality.

Moreover, the previous empirical literature has covered the economic growth and environmental degradation relationship, innovation and environmental degradation relationship, and political institution relationship with environmental quality separately, and most of the empirical literature appeared with mixed and contradictory results.