A Study on the Relationship Between Economic Growth and Carbon Dioxide Emission: A Comparative Study in Pre-COVID Period

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ABSTRACT

The relationship between economic growth and CO2 emission has been a widely researched topic in the global context. This paper intends to shed light on the relationship between economic growth and CO2 emission in selected group of countries with special comparison between Sri Lanka and each country since it is the research gap identified by the researchers. The objective of this paper is to investigate the relationship between economic growth and CO2 emission in Sri Lanka in comparison with the reference countries. Examining the impact of the size of urban/rural population, GDP growth rate and electric power consumption on CO2 emission are specific objectives. The group of countries selected for this study are Sri Lanka, India, Norway, and the United States of America. This study uses secondary data for each country collected from the World Bank database for the period of 1994-2018. A period of 25 years with 20 cross sections draws 500 total observations. The Fixed Effect Panel Regression (FEPR) method is applied by using SPSS software as the analytical tool of the study. As expected, the p values of the study showed that there is a high impact of economic growth on CO2 emission in Sri Lanka and USA. Further, the study found that the economic growth of India and Norway have less effect on CO2 emission compared to Sri Lanka and USA. The study also found that the size of urban and rural population has a direct impact on CO2 emission in selected countries while GDP growth rate and electric power consumption has no impact into CO2 emission. The study concludes that overall population of selected countries has significant impact on CO2 emissions since the increase in both urban and rural population has led to higher CO2 emission. Further, the research confirms the Environmental Kuznets Curve analysis since the results show that the countries with higher GDP growth rate and electric power consumption are contributing to lower CO2 emission. Finally, the research suggests that the Sri Lankan policy makers to implement a suitable program to lower the environmental degradation within the country. Developing or importing appropriate and advanced technology can minimize the environmental impact on developing process.

Keywords: Economic Growth, CO_2 Emission, Urban/rural Population, GDP Growth Rate, Electric Power Consumption

INTRODUCTION

The relationship between economic growth and Carbon Dioxide (CO2) emission has been a widely researched topic in the global context. This study intends to shed light on the relationship between economic growth and CO2 emission in selected group of countries with special comparison between Sri Lanka and each country since it is the research gap identified by the researchers. Despite environmental issues, certain facts of the atmosphere, such as water pollution, carbon dioxide emissions (CO2 emissions), soil depletion, solid waste, and deforestation, refuse to be included. However, due to a lack of time and data on other causes, this study focused on per capita CO2 emission as a proxy for environmental degradation to provide an overview of Environmental Kuznets Curve.

Environmental Kuznets Curves are the most well-known and studied application of environmental econometrics. Alternative data sets, various individual pollutants and aggregate indicators, various estimation

techniques, several functional forms, non-parametric analyses, dynamic considerations, transition, regime-shifts, and other types of non-linearities are all considerations that can and have been made, all with the goal of determining whether a fundamental hump-shaped relationship between a pollutant and its environment exists. It's important to remember that an EKC partnership can only act as an ex-post check on a pollutant's ability to act in response to economic growth. Whatever its shape, it cannot serve as an unconditional intellectual framework for policies that promote economic development, nor does it serve as a blueprint that can be exported to other countries or pollutants. There are a number of observational findings on CO2 and economic growth, in addition to observations that test the EKC hypothesis. The studies are divided into two categories: those that used regime switching/threshold models and those that used non-regime switching models. This classification would aid in the proper placement of the present thesis in the literature. Environmental emissions and energy usage are only a couple of the main factors that concern development economists, resource economists, and environmental economists in contrast to previous crude growth models that focus heavily on labor and capital as key productivity factors and ignore the importance of resources in the growth process (Stern, 2011). Many scholars have been studying the causal link between energy demand and macroeconomic conditions over the last two decades. Numerous studies have looked at the causal association between energy consumption and a variety of independent variables, including economic growth, financial development, jobs, and population.

Recently, many natural disasters were reported as a result of global warming and the environmental degradation. Therefore, the studies on this issue is an essential need of the globe today. This study is trying to address this severe issue in various terms of environmental degradation as a comparative study.

In the real world, climate change is one of the main problems that has an economic, cultural, and ecological effect on civilization. Through the industrial revolution, greenhouse emissions have boosted the use of fossil energy, which is one of the world's major roots of global warming and climate change. In observational research, carbon emissions are being used as an indicator for environmental destruction. The explanation for this is that there is a historical correlation between carbon emissions and economic development. The question remains, however, why countries have varying levels of per capita carbon emissions with a comparable per capita income level. Many studies have attempted to research the correlation between environmental destruction and economic development, along with other significant variables that fall into the framework, to find a correct response to this crucial issue. The theory of the Environmental Kuznets Curve (EKC) is a regular feature in environmental policy scientific literature. This theory reveals an inverted U-shape nexus between the amount of sales and environmental destruction (Barrett, 1997).

It is possible to classify the phenomenon of urbanization as a critical determinant of economic development and economic structure. However, a recent pattern is comprehensive urbanization, which is among those that have been described as an advanced modern economic growth phase. While the relationship between urbanization and economic growth is strong, it is difficult to determine whether economic growth induces urbanization or whether economic growth is triggered by urbanization. On the other hand, industrial energy consumption and carbon emissions can be increased by the urbanization process. Several studies also included urbanization both in emerging and industrialized economies as causes of environmental deterioration. Different regression approaches are used to approximate the relationship between pollution growth in CO2 emissions per capita and past CO2 emission levels, past GDP levels and GDP growth. This basic specification is a reduced form feature de-developed from a theoretical capital accumulation growth model known as the "Ramsey- Koopman-Cass" model.

Urbanization has both positive and negative environmental consequences. The environmental effect of urbanization varies with the pace of growth. A strong association between urbanization and carbon emissions has been found in many studies. Moreover, the process of urbanization and electricity intensifies the environmental level of carbon emissions. As a consequence of higher living standards in urban life, overall energy use and greenhouse emissions are positively associated to the urbanization process. Urban people also try to buy goods that are extremely energy consuming. Industrial urban habits thereby contribute to a rise in overt and indirect energy use, leading to global warming and climate change as a result. Urbanization is often at the centre of an economy's socio-economic growth (Barrett, 1997).

All economic growth nodes, such as banking, connectivity, and transportation, are located in cities. In contrast, city living is still complicated, and urban energy consumption is far higher than in rural areas. As a result, energy use in urban areas has a direct effect on the environment's health, and urbanization is one of the most important considerations in predicting the world's future carbon emissions.

Grossman and Krueger (1994) argued that trade liberalization will result in less environmental degradation for two very important reasons. Second, because of the increase in national wealth, trade liberalization may result in higher levels of income and citizens may demand a healthy environment. Second, trade liberalization policies can facilitate foreign direct investment, and as a result, advanced technologies can be transferred to the local economy. As a result, since modern technologies are safer than older technologies, production practices may have a lower environmental impact. Additionally, have supported this statement that, moreover, trading structure matters to the environment; whether the traded goods are environmentally sustainable, trade will enhance environmental sustainability. The effects of trade on the atmosphere can be explained based on scale, technique, and hybrid influence. The scale's result is based on the argument that trade liberalization leads to a substantial reduction of capital in exchange for higher production, resulting in increased carbon emissions. Though trade's technological impact extends to the transition of technologies between nations, development is rendered environmentally friendly by constructive processes. Furthermore, trade increases domestic competition, forcing domestic producers to rely on active production techniques. Finally, the composition of exports and imports is referred to as a result of composition.

If a country's trade in cleaner manufacturing outnumbers its polluted industry, trade will decrease emissions. If dirty industries outnumber trade, trade will worsen the environment. As a result, the literature is divided about whether trade improves or worsens the environment. Sri Lanka is a low middle-income island with a population of 21 million people, located in the south-eastern corner of the Indian subcontinent. Sri Lanka was the first South Asian nation to liberalize its trade and investment regime in 1978. Trade transparency, which is the international trade to GDP ratio, as seen for the chosen South Asian countries in If one contrasts the Sri Lankan economy with other big South Asian economies from 1978 to 2008, the trade-to-GDP ratio is very high for Sri Lanka. However, Sri Lanka's commercial transparency has fluctuated by about 50 percent since 2009.

In 2016, the Sri Lankan economy was worth US$ 83 billion, with a per capita income of US$ 3835. The economy's main industries are inbound tourism, tea exports, textile and luxury goods, cotton, and other agricultural items. Sri Lanka, on the other hand, is transitioning to a knowledge-based economy, having produced the world's second-largest number of chartered accountants. The country's significant human development accomplishments are well established. Nonetheless, economists and policymakers have referred to it as a transitional economy. Sri Lanka is also considered one of the world's least urbanized countries, according to the United Nations. About 81.7% of the country's population now resides in rural and plantation-dependent areas based on agriculture and agro-based industries. Accordingly, the social and living conditions of people in Sri Lanka often vary greatly between rural and urban areas. In the chosen South Asian countries, the urban population scenario. In Bangladesh, India and Pakistan, the proportion of the urban population is constantly rising, while Sri Lanka has seen a small decline in its urban population.

Various natural disasters have been plaguing Sri Lanka in recent years. Carbon emissions in the world are steadily rising, which is one of the indicators of environmental degradation. Sri Lanka's National Environmental Action Plan, which ran from 1992 to 1996, was designed to establish an environmental protection plan within the framework of progress in order to combat environmental degradation. Importantly, this national environmental action plan includes both corrective and preventive measures in areas such as food waste, energy, water and land use, urban emissions, water and land resources, wetlands and wildlife, aquatic resources, education and culture. However, despite such a programme, as a consequence of numerous socio-economic practices, environmental destruction in the world has increased rapidly. Therefore, environmental problems in Sri Lanka need researchers to pay heed. Although some studies have been carried out in this respect in the past, described the impact of economic growth and energy use on Sri Lankan carbon emissions in a report. In the other hand, in the sense of the island's transitional economy, where urbanization is a relatively limited proportion of the population in liberalized economic environments, no related research has been found on the same phenomenon. In addition, in the case of Sri Lanka, no research has so far used boundary tests for an unexplained structural crack.

Sri Lanka, by contrast, has a warm climate, but urbanization does not increase energy consumption and urbanization does not lead to the concentration of carbon dioxide in the atmosphere of a small island. Another fact about the negative relationship between urbanization and carbon emissions is that the human development index of Sri Lanka is high in comparison to the South Asian region. This means that, even in rural areas, the Sri Lankan government is effective in distributing essentials, resulting in a less urbanized population. At any possible step, the implications of climate change are examined: global, international, state and local, pressing for action at multiple levels. Sri Lanka, a tropical region, is highly vulnerable to the adverse impacts of climate change. Action at the national level has a vital role to play, while international cooperation is still important.

Lately, numerous natural disasters have gradually affected Sri Lanka. In the planet, the volume of carbon dioxide, one of the indicators of environmental degradation, is continuously rising. The Sri Lankan National Environmental Plan was then implemented in order to create an environmental protection plan in order to combat environmental degradation. Importantly, this national environmental action plan consists of both corrective and mitigation initiatives in areas such as agricultural waste, energy, water and land use, urban emissions, water and land supplies, ecosystems and habitats, aquatic resources, education and culture. However, despite the existence of such a programme, because of numerous socio-economic practices, environmental destruction in the world has reached a height. Environmental problems in Sri Lanka therefore require researchers' consideration.

MATERIALS AND METHODS

The study relies on panel data from 1994 to 2018. Sri Lanka, India, Norway and USA were chosen as the sample group of countries because data on all of the variables of interest are available. All the data were collected from the World Bank profile for each country. CO2 emissions are calculated in metric tons per capita as CO2 emissions. The researchers have used SPSS software to test the Fixed Effect Panel Regression as the analyzing tool to achieve the objectives. Fixed-effects regression (FE) is a technique that is especially useful in the context of causal inference.

Dependent Variable:

- CO2 emissions per Capita

Independent Variables:

- Urban population (% of total population)
- Rural population (% of total population)
- GDP growth (annual %)
- Electric power consumption (kWh per capita)

Hypothesis Development:

Sri Lanka

H0: There is no relationship between Economic Growth and the CO2 emission in Sri Lanka

H1: There is a relationship between Economic Growth and the CO2 emission in Sri Lanka

India

H0: There is no relationship between Economic Growth and the CO2 emission in India

H1: There is a relationship between Economic Growth and the CO2 emission in India

Norway

H0: There is no relationship between Economic Growth and the CO2 emission in Norway

H1: There is a relationship between Economic Growth and the CO2 emission in Norway

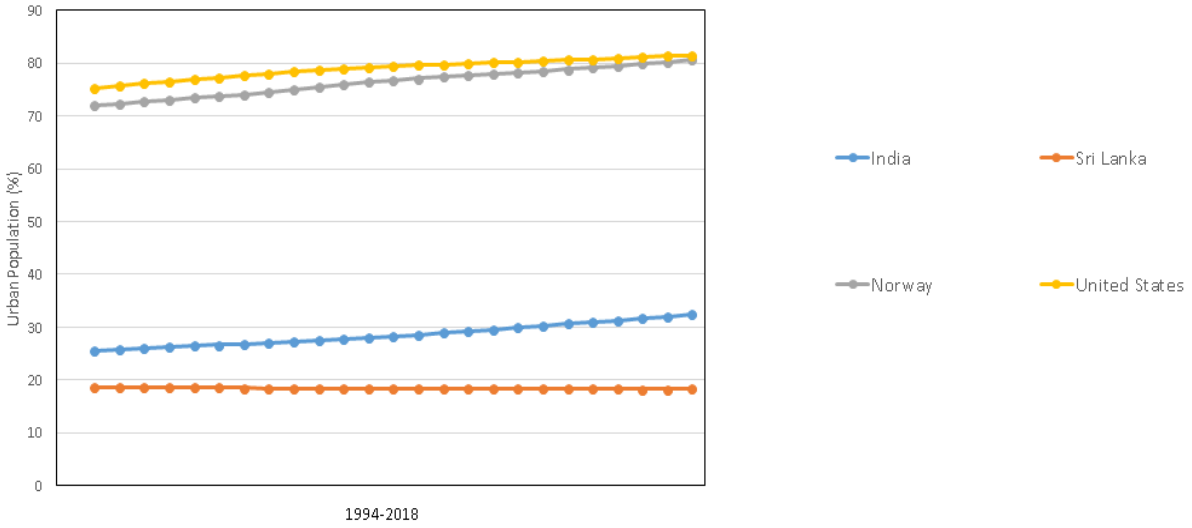
USA

H0: There is no relationship between Economic Growth and the CO2 emission in USA

H1: There is a relationship between Economic Growth and the CO2 emission in USA

RESULTS AND DISCUSSION

Figure 01 : Urban population Behavior (As a % of total population) in selective Countries



Source: World Bank

Figure 02 : GDP Growth Rate (Sri Lanka) 1994-2018

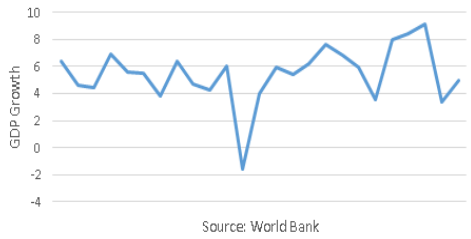


Figure 03: GDP Growth Rate (India) 1994-2018

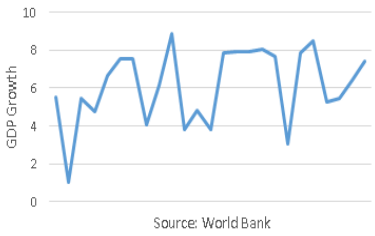


Figure 04: GDP Growth Rate (Norway) 1994-2018

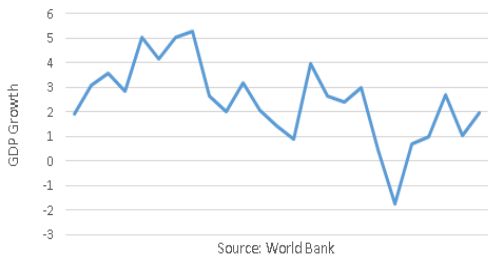


Figure 05: GDP Growth Rate (USA) 1994-2018

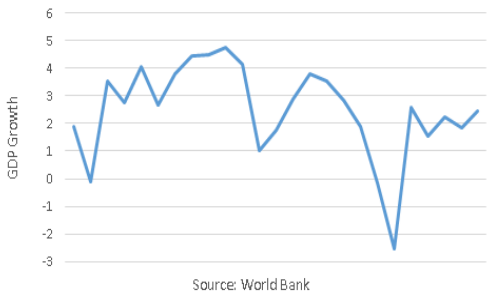


Figure 06: Electric Power Consumption (Sri Lanka) 1994-2018

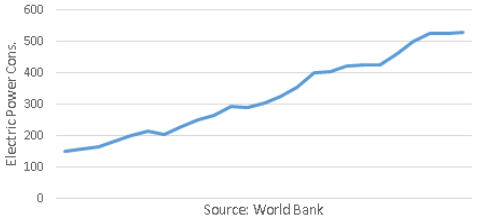


Figure 07: Electric Power Consumption (India) 1994-2018

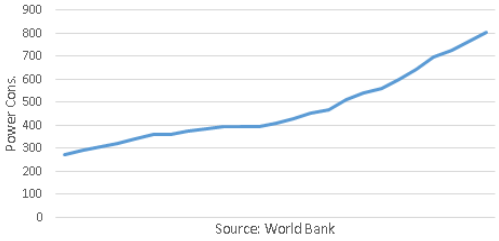


Figure 08 : Electric Power Consumption (Norway) 1994-2018

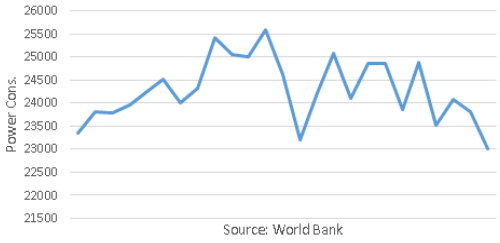


Figure 09: Electric Power Consumption (USA) 1994-2018

Figure 10: CO2 Per Capita (Sri Lanka) 1994-2018

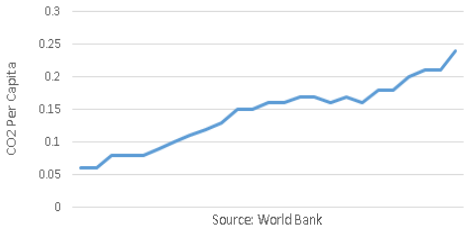


Figure 11: CO2 per Capita (India) 1994-2018

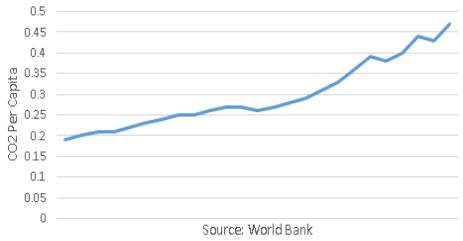


Figure 12: CO2 Per Capita (Norway) 1994-2018

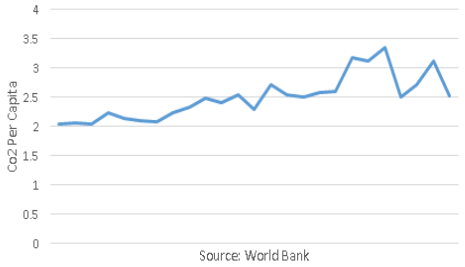
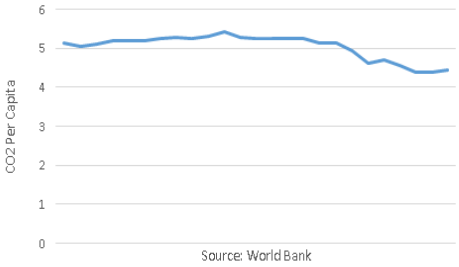


Figure 13: CO2 Per Capita (USA) 1994-2018



The above figures show that USA and Norway have higher urban population compared to Sri Lanka and India. GDP growth rate of all the countries have some fluctuations and the electric power consumption of Sri Lanka and India have a continuous increase. CO2 emission per capita of all the countries in given sample have a regular increase according to the data collected by the researchers.

Table 01: Regression Output

Method: Fixed Effect Panel Regression
Sample: 1994 – 2018
Periods Include: 25
Cross Section: 20
Total Observations: 500

Variables	Coefficient	Std. Error	t-statistics	Sig.
(Constant) Sri Lanka	3.452	1.108	3.115	0.002
India	-0.258	0.155	-1.67	0.098
Norway	-0.414	1.37	-0.302	0.763
USA	2.218	0.917	2.419	0.018
Urban Population	-0.048	0.014	-2.996	0.003
Rural Population	-0.04	0.014	-2.961	0.004
GDP Growth	-0.004	0.014	-0.306	0.76
Electric Power Consumption	1.709	0	0.293	0.77

Source: Author's calculation using SPSS

Main Objective of the study: Comparatively identifying the relationship between economic growth and the quality of the environment in selective countries

Sri Lanka

Under the 95% confidence interval level the sig. value is 0.002. H0 reject at this level. There is a relationship between economic growth and the CO2 emission in Sri Lanka.

India

The sig. value is 0.098. There's no evidence to reject null hypothesis. There's no relationship between economic growth and the CO2 emission in India.

Norway

The sig. value is 0.763. There's no evidence to reject null hypothesis. There's no relationship between economic growth and the CO2 emission in Norway.

USA

The sig. value is 0.018. Null hypothesis rejected. There is a relationship between economic growth and the CO2 emission in USA.

Specific Objective 01: To analyze the impact of Urban/rural population into Co2 emissions.

Hypothesis Development:

H01: There is no relationship between urban population and CO2 emissions.

H11: There is a relationship between urban population and CO2 emissions.

H02: There is no relationship between rural population and CO2 emissions.

H12: There is a relationship between rural population and CO2 emissions.

Discussion

The fixed effect panel regression resulted a sig. value of 0.003 for the hypothesis testing in relationship between urban population and CO2 emissions. Here the researcher conclude that there's a direct impact of urban population into the CO2 emission in selective countries. The researchers argue here that the urban population has a direct effect on the nature of the atmosphere in selected countries. Urban populations engage with their surroundings. Through their use of food, electricity, water, and property, urban people change their climate. The polluted urban climate, in fact, impacts the health and quality of life of the urban population.

The fixed effect panel regression resulted a sig. value of 0.004 for the hypothesis testing in relationship between rural population and CO2 emissions. Here the researcher conclude that there's a relationship between rural population and the CO2 emission in selective countries.

Specific Objective 02: To analyze the relationship between economic growth rate and the CO2 emissions.

Hypothesis Development:

H0: There is no relationship between economic growth rate and CO2 emissions.

H1: There is a relationship between economic growth rate and CO2 emissions.

Discussion

The relationship between the economic growth rate and CO2 pollution. The regression of the fixed impact panel resulted in a sig. Price of 0.760 for the verification of the hypothesis in comparison to GDP growth rate and CO2 emissions. No proof exists to refuse the null hypothesis. The researchers agree that global warming is potentially one of the greatest threats that society will face in the future but there's no direct impact of GDP growth rate into the CO2 emission in selective countries.

The nature of the topic is genuinely universal, as it encompasses all of the world's nations and nearly every element of human activityIt would undoubtedly take decades to identify suitable and implementable alternatives and demand tremendous efforts by policymakers, researchers and entrepreneurs. Any effort to make a contribution to the domain could appear as a reckless and presumptuous exercise in the face of these considerations (Barrett, 1997)

Specific Objective 03: To analyze the relationship between economic growth rate and the electric power consumption.

Hypothesis Development:

H0: There is no relationship between electric power consumption and CO2 emissions.

H1: There is a relationship between electric power consumption and CO2 emissions.

Discussion

The fixed effect panel regression resulted a sig. value of 0.770 for the hypothesis testing in relationship between electric power consumption and CO2 emissions. There is no evidence to reject null hypothesis. Here, the researcher conclude that there's no direct impact of electric power consumption into the CO2 emission in selective countries.

CONCLUSION

The relationship between economic development and environmental conservation has been discussed in this article. It sought to determine whether the two are compatible or whether the latter is undermined by the former. This is critical in outlining strategies that, like the Millennium Development Goals (MDGs), seek to reduce (and

likely eradicate) poverty through economic growth. It indicates that there is no strong proof that growth and CO2 emissions have a negative relationship. There is no evidence of an EKC-type relationship, which implies that as income tends to increase, there is a degree of income after which emissions are decreased. The lack of evidence of a downward trend is mostly absent (the right-hand part of the theoretical inverted-U shape). Trends in emissions in developing countries still do not indicate such a pattern. Most notably, they reveal very different curves, and a common structure or pattern cannot be derived. This illustrates that the conservation of the environment is closely connected to national attributes and national approaches to environmental problems. This paper intends to give the followings as the main conclusions of the study.

- There is a high impact of economic growth on CO2 emission in Sri Lanka and USA.
- Economic growth of India and Norway have less effect on CO2 emission compared to Sri Lanka and USA.
- Here, the research confirms the Environmental Kuznets Curve analysis since the results show that the countries with higher GDP growth rate and electric power consumption are contributing to lower CO2 emission.
- Urban and rural population directly effects to environmental quality (CO2 emission). When urban population goes up, CO2 emission will rise simultaneously.

In 1978, relative to 50 percent in 2014, fossil fuel energy was 27 percent, so fossil fuel energy has grown. The burning of renewables in total electricity was tiny in 1990, but its share reached nearly 10 percent in 2014. Similarly, Sri Lanka witnessed an increase in coal's share of electricity production from 9 percent to over 25 percent during 2011-2014. The proportion of renewable energy in total energy consumption was slightly higher than 78% in 1990, while this proportion stood at around 57% in 2014. Similarly, this suggests that Sri Lanka has seen a reduction in electricity from renewable energies and, as a result, Sri Lankan energy is blamed for environmental degradation. Sri Lanka will offset the impact of energy from non-renewable resources by rising the share of power from renewable resources. One of South Asia's most suitable conditions for hydropower is Sri Lanka. The country's production of electricity is largely focused on hydropower. The government is seeking an energy-autonomous economy by 2030. However, climate change has had a negative effect on the hydroelectricity generation capacity of the country in recent years. Sri Lanka, which is a tropical region, is highly vulnerable to the effects of climate change. The Green Economy principle must also be seen by the country's leaders as a primary solution to addressing the challenge of climate change.

The findings of this research have shown that in Sri Lanka, the EKC theory does not prevail in the long term or in the short term. This means that the economy of Sri Lanka has not achieved a revenue level where a further rise in revenue results in a lower degree of carbon emissions. This indicates that the reduced pollution levels are not balanced by a rise in the cost of wages. This analysis result is consistent with previous study reports, such as Gamage et al, whose study in Sri Lanka has failed to support the EKC hypothesis. This study's findings show that long-term environmental depletion benefits from market entry. Cole et al., and Nasir and Rehman are consistent with this observation. Tourism, tea exports, textile and fashion products, rice and other agricultural items are the major sectors of the Sri Lankan economy. The beneficial effects of trade on habitat loss, however, will rely on trade size, strategy and hybrid outcomes. The influence on scale could increase carbon emissions as the nation's economic size is increased by higher exports. This also clarifies why Sri Lanka's domestic investors have not used environmentally friendly technologies. Additionally, manufactured equipment is not environmentally sustainable in the context of machinery. This suggests that Sri Lanka's international trade is not environmentally sustainable, but we are not sure if this is due to the country's exports or whether imports are responsible for this positive effect on the depletion of the environment, so it is proposed that future studies identify exports and imports as sources of environmental degradation.

POLICY RECOMMENDATIONS

- Finally, the research suggests that the Sri Lankan policy makers to implement a suitable program to

lower the environmental degradation within the country. Developing or importing appropriate and advanced technology can minimize the environmental impact on developing process.

- Urban areas should be more focused in environmental conservation programmes.

This research indicates that the interventions required to make trade beneficial to the environment should be pursued. This is only possible by the implementation of environmentally efficient policies for domestic production processes and the development of initiatives to make imports more environmentally friendly. The government should focus more on advanced technologies which can minimize the environmental impact in development process.

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HIGHLIGHTS

- According to the Fixed Effect panel Regression Analysis, the study showed a higher impact of economic growth on CO2 emission in Sri Lanka and USA. Further, the study found that the economic growth of India and Norway have less effect on CO2 emission compared to Sri Lanka and USA.

- The study also found that the size of urban and rural population has a direct impact on CO2 emission in selected countries while GDP growth rate and electric power consumption has no impact into CO2 emission. The research confirms the Environmental Kuznets Curve analysis

- The research suggests that the Sri Lankan policy makers to implement a suitable program to lower the environmental degradation within the country. Developing or importing appropriate and advanced technology can minimize the environmental impact on developing process.