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Impact of Economic Growth, Population, and Energy Consumption on Environmental Degradation in Emerging South Asian Economies

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Abstract

Climate change in the global world, because of carbon dioxide (CO_2) emissions has become a serious issue. Due to these factors, emerging economies of South Asia are facing the threats of CO2 emissions, global warming, and climate change. The objective of this study was to analyze the impact of economic growth, population, and energy consumption on environmental degradation from 1990 to 2019. In this work, two sets of methods Panel Auto Regressive Distributive Lag Model (ARDL) and Fixed Effect Models are used. The outcome of ARDL suggested that in the long run, CO_2 emissions have a positive relation with energy consumption, whereas negative relation with GDP per capita and population. In the short run, CO_2 is positively impacted by energy consumption and population while it has negatively impacted by GDP per capita. Moreover, the results of the Fixed-effects model also validated the same results. This study recommends that all three countries should replace non-renewable and fossil fuels with clean and green fuels by investing in modern technologies.

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1.1 Introduction

Global warming and global climate change have recently become the most important issues worldwide. There is a day-by-day increase in greenhouse gases. Developing nations generally face the more awful impact of these gases emission. The one significant source of greenhouse gasses is Carbon dioxide (CO_2). The general earth's temperature is increasing because of this cause. A report by The World Bank (2007a) stated that 58.8 percent of global warming and climate change are caused by the main greenhouse gas i.e. CO_2 emission which is also called a global pollutant. According to research by ActionAid, approximately 62 million people will be displaced in South Asia by 2050 due to the adverse impact of climate change. According to World Bank's South Asia climate roadmap, in the last 2 decades, 750 million people in South Asia are affected by one or more climate-related disasters.

As per the report of the intergovernmental board in 2007 on the changing environment, the normal worldwide temperature would be increment within the next 100 years. The extra expansion in the temperature would hamper the economic framework and this could be the reason for the rise in ocean level that would be hurtful for those individuals who are living in waterfront regions i.e. threatening in this report. Socio supportability of the country will influence by the further expansion in the force and recurrence of an outrageous flood, water vulnerability, high temperature, soil debasement and so on answerable for a dangerous atmospheric deviation will lead by the CO_2 emission which straightforwardly influences the nature of water and land (Naqvi & Rehman, 2014).

There ought to be found a few ways to stop or control the CO_2 discharge to have feasible financial advancement. Monetary action per individual is prosperity. It very well may be taken as a way of life. GDP per capita is one of the key components contributing to CO_2 discharge. Financial turn of events and climate quality have an extremely close and solid connection and have been broadly thought consideration (Mansoor & Sultana, 2018). Industrialization and advancement are key drivers of monetary development and significant sign of ecological debasement both in amount and quality. Decay of the climate is the natural corruption through the consumption of assets like air, water, and soil; the obliteration of environments; territory annihilation; the eradication of untamed life; and contamination (Conservation Energy Future [CEF], 2016).

Environmental degradation results in the developing utilization of energy have been the central explanation for increased carbon emissions contended by various specialists. Developing concern from one side of the planet to the other has been environmental change and its effect(Islam et al, 2017). The temperature of the earth is enhanced through the emanation of gas by the utilization of fossil fuels which is increased by a source of energy consumption (Menyah and Wolde-Rufael, 2010). A tremendous measure of greenhouse gas emissions, including carbon dioxides, nitrous oxide, and methane the cause of environmental degradation (Yang and Li, 2017). A significant supporter of contamination is the burning of fossil fuels. A major reason for the contamination of non-renewable (fossil fuels) energy is consuming more than 98% in Pakistan which might be directed to climate fiasco (Sheik, 2010). The utilization of petroleum derivatives for day-to-day existence, enormous smoke removal from the processing plants, and utilization of wood as an energy source help the CO2 outflows (Shahbaz et al, 2013). A more significant level of energy utilization is required by higher monetary development and is liable for more elevated levels of CO2 outflows (Ghosh et al, 2014). The economy and different areas like farming and forestry are ruinously affected by Carbon dioxide emissions.

The impacts of energy utilization and financial development on CO2 emanations have been conducted by an enormous number of past examinations, but they used total energy consumption as a proxy for energy consumption and studies on the sorts of energy are as yet scanty. Shaari et al., (2020) stated that two sorts of energy: inexhaustible and non-sustainable energy split by a set number of studies. Abundance creation promotes by financial activity however negatively affects the climate. Tremendous amounts of waste and defilement, making degradation to natural resources produced by the creation frameworks presently utilized in industrialized nations. Alam et al., (2007) stated that as long as population builds leads to expansions in energy utilization and thus, to more noteworthy climatic contamination, these effects are more extreme when joined by demographic development.

The rising populace with low work efficiency, the disparity in pay circulation, and high joblessness are significant reasons for the deterioration of the climate in developing countries. For instance, consuming woodlands and changing over them into cropland prompts a natural unevenness in utilizing the land. Due to the over-collection of fuel wood from timberlands deforestation likewise prompts development in population; this further prompts soil disintegration and flooding in bumpy regions (Sengupta, 2010). Sengupta (2010) stated that the stressing of environmental resource base past its carrying limit is caused by the tension of population in such economies.

The private fossil fuel byproducts are especially impacting Pakistan, India, and Bangladesh[4]. For instance, roughly 280,000 deaths each year are occurred by such outflows in Pakistan. 4–6% of the public rate of illness is done this kind of contamination in India (WHO, 2016). Note that, energy utilization, per capita GDP, and populace size are significant factors responsible for changes in fossil fuel byproducts, at a territorial level. In the South Asian region, a 7.28% GDP development rate experienced by Bangladesh positioned the nation as second, a 6.68% development rate positioned India third, and a 5.70% development rate positioned the country fourth to Pakistan, in 2017 (World Bank, 2019). CO_2 discharges are a significant misery for India as well as for the entire world, with the coming of different innovation infringements and steadily advancing monetary development with the expanding energy utilization per capita. An issue of the main concern in India has been reasonable monetary development, since freedom. For a high and manageable financial development, ecological assurance should be considered, with moderate monetary development. As it stayed the third biggest energy shopper on the planet India's energy utilization developed by 5.4 % in 2016, as per BP statistical (2017). As a CO_2 producer making India the third biggest nation in the world, India has 2088 $MtCO_2$ CO_2 outflows from fuel utilization (Global Energy Statistical Yearbook, 2017). The interest in energy is additionally expanding quickly, like another arising country in Bangladesh. The adjustment of the economy, development in population, urbanization, and industrialization the

[4] Reasons to choose these three countries are given below?

1. The main reason to select these countries is that these countries are called subcontinent countries (these got independence from each other).
2. The second reason is that these three countries are badly affected by climate change (also present at high ranks in global climate risk index).
3. The third reason is that these three countries are highly populous in South Asia.
4. The fourth reason is that these three countries have some sort of cultural, language and border linkages.
5. India is the first larger country by area in South Asia, Pakistan is the second larger country and Bangladesh is the fourth larger country by area after India, Pakistan and Afghanistan in South Asia.

quick development in the utilization of energy in Bangladesh followed.24.3 Million Tons of Oil Equivalent (Mtoe) in 2011 by the utilization of essential energy, and this figure came to 32.99 Mtoe in 2017. By 185% the power demand will increment it is normal in 2020 (Sarkar et al 2019).

The channel in the graph shows that energy consumption increases CO_2 emissions which implies energy utilization can add to higher natural debasement. Similarly, the population increases the CO_2emissions and adds to higher ecological debasement. On the other hand, economic growth (GDP) negatively influences CO2 emissions which means economic growth cannot contribute to higher environmental degradation (Mansoor and Sultana, 2018). Explicitly in the current review, we select explanatory variables which are energy consumption, economic growth, and population to investigate their effect on environmental degradation (direction is explained in Fig 1) with regards to Pakistan, India, and Bangladesh.

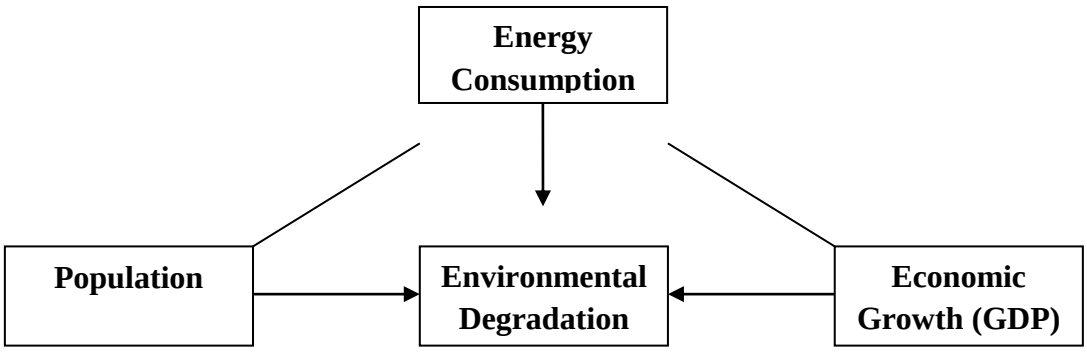

Figure 1: Forces Adding to environmental degradation

This goes hand in hand with the exploitation of the climate everywhere gauges the human population on earth is extending dramatically. The inordinate population development is the essential driver of ecological crumbling and Natural corruption is turning into an inexorably dismal danger to the prosperity of the population. The need to deliver buyer items expands with population development and this need, thusly, escalates the pattern to abuse natural assets and over-exploit. An increase in real output means financial development which also causes environmental degradation ultimately. Accordingly, we are probably going to see costs forced on the climate with expanded yield and utilization. The expanded utilization of non-inexhaustible assets, more elevated levels of contamination, a dangerous atmospheric deviation, and the possible loss of ecological territories incorporate the natural effect of monetary development. Nonetheless, harm to the climate is not caused by all types of monetary development. People have a more noteworthy capacity to devote assets to ensuring the climate and moderating the unsafe impacts of contamination, with rising genuine salaries. Additionally, with less contamination monetary development brought about by further developed innovation can empower higher output. Since individuals use non-sustainable power, for example, petroleum derivatives, coal, flammable gas, oil, and thermal power which seriously impacts the climate additionally, energy utilization is likewise the significant reason for natural debasement.

This work is organized into five parts, part one consists of the introduction section, part two consists of a literature review, part three comprises data and methodology, part four comprises estimation and results and part five is about conclusion and policy recommendation.

1.2 Literature Review

Regarding the effect of population growth, economic growth, and energy consumption on carbon emissions in Pakistan, India, and Bangladesh, extensive research has been documented. In Pakistan, Khan et al., (2020) used time series data from 1965 to 2015 to investigate the connection between energy consumption, economic growth, and carbon dioxide emissions. According to the findings, in both the short and long run, CO_2 emissions in Pakistan are increased by energy use and economic growth. Similarly to this, Mansoor and Sultana (2018) examined the effect of Pakistan's population, GDP, and energy consumption on carbon emissions. The findings indicate that population growth and energy demand both lead to an increase in CO_2 emissions, while the long-term relationship between GDP and CO_2 emissions is negative. Whereas, Islam et al. (2017) examined the relationship between environmental degradation (carbon emissions), economic growth, total energy consumption, and industrial production index growth in Bangladesh from 1998 to 2013. They found a significant relationship between industrial production and GDP per person and carbon emissions. The Environmental Kuznets Curve (EKC) theory is compatible with the long-term effects of carbon emissions on industrial production, which are substantial in the short term but diminish with time.

Sehrawat et al., (2015) used time series data from 1971 to 2011 to investigate the impact of financial development, economic growth, and energy use on environmental deterioration in the Indian economy. The finding supports the presence of a long-run linkage between the variables. India's financial development looks to be worsening environmental degradation. Economic growth, energy consumption, financial development, and urbanization are the primary causes of environmental degradation. The findings also confirm the existence of environmental Kuznets curves in the Indian economy. Similarly, Yang and Zhao (2014) evaluated the association between energy consumption, carbon emissions, and economic growth in India from 1970 to 2008. The study's findings reveal that energy consumption generates carbon emissions and economic growth uni-directionally, while carbon emissions cause economic growth bi-directionally. The findings also reveal that trade openness is a significant driver of energy usage and carbon dioxide emissions.

Whereas, Khan et al., (2019) examined the effects of energy use, environmental degradation, economic growth, and financial development in 193 nations from 1990 to 2017. According to empirical evidence, financial development, economic expansion, energy consumption, and carbon emissions, all have an impact on one another. With the spread of high pollution, energy consumption also increased, which reduces financial development. For the worldwide panel, all models confirm the existence of the Environmental Kuznets curve. Similarly, Jamel and Derbali (2016) looked into the effects of energy consumption and economic growth on environmental degradation for a panel of eight Asian nations from 1991 to 2013, namely China, India, Thailand, Japan, Malaysia, Singapore, Indonesia, and South Korea. The findings reveal the long-run relation between environmental degradation, energy consumption, and economic growth, as well as financial development, trade openness, capital stocks, and urbanization as control variables. Furthermore, FMOLS results indicate that economic growth and energy consumption have a significant positive impact on environmental degradation.

Furthermore, panel causality via VECM confirms the existence of a bidirectional causative connection between energy consumption, economic growth, and environmental degradation. Similarly, Ali et al., (2020) investigated the relationship between environmental deterioration, economic growth, and energy innovation using panel data from 33 European nations from 1996 to 2017. The outcome demonstrates that all variables are integrated with the long run. Energy innovation has a substantial and negative impact on environmental degradation. Gross domestic product, on the other hand, exhibits a U-shaped and strong association with environmental deterioration, validating the Kuznets curve. Similarly, Saidi and Hammami (2015) looked examined how CO2 emissions and economic growth affected the consumption of energy in 58 nations. This link is estimated for three regional panels: Europe and North Asia, Latin America and the Caribbean, and Sub-Saharan, North Africa, and Middle Eastern. They discover that the influence of economic growth on energy consumption is positive and statistically significant in the worldwide panel using the Generalized Method of Moments. CO2 emissions have a statistically significant positive effect on energy usage in the four panels. This means that economic growth, CO2 emissions, and energy use are all interconnected. Only the worldwide panel shows a positive and statistically significant impact of financial development on energy consumption. Similarly, Al-mulali and Sab (2012) investigated the impact of energy consumption and CO2 emissions on GDP growth and financial development in thirty Sub-Saharan African countries from 1980 to 2008. The paper's findings revealed that energy consumption played a key role in increasing both economic growth and financial development in the economies studied but at the expense of excessive pollution. In addition, Anser et al., (2019) examined the impact of urbanization, economic growth, and population increase on residential carbon emissions in South Asian Association for Regional Cooperation (SAARC) member countries from 1994 to 2013. According to the findings, population size and per capita GDP are the primary determinants of high carbon emissions in SAARC countries. They also show that there is a U-shaped link between urbanization and residential carbon emissions: residential carbon emissions reduce initially with increased urbanization and subsequently increase with increased urbanization. Liu (2005), on the other hand, investigated the link between CO2 emissions and national GDP. The researcher analyzed panel data from 1975 to 1990 for 24 OECD nations in this study, which suggests a negative link between national income and CO2 emissions.

Rahman et al., (2020) investigated the effects of CO2 emissions, population density, and trade openness on economic growth in five South Asian nations (Bangladesh, India, Nepal, Pakistan, and Sri Lanka). The findings suggest that CO2 emissions and population density have a favorable impact on South Asian economic growth whereas trade openness has a negative impact. The Granger causality results show a bidirectional relationship between economic growth, CO2 emissions, and trade openness. Similarly, Aye and Edoja (2017) used the dynamic panel threshold approach to evaluate the effect of economic growth on CO2 emissions. This analysis is based on panel data from 31 developing nations from 1971 to 2013. According to the study, economic growth has a negative impact on CO2 emissions while the economy is in the low growth regime but a positive effect when the country is in the high growth regime. The effect is stronger in the high-growth regime. As a result, the validity of the Environmental Kuznets Curve (Inverted-U) hypothesis for these panels of countries over the study period could not be demonstrated. Energy usage and population also have a positive and significant impact on CO2 emissions. Furthermore, Shaari et al. (2020) examined the impact of oil and gas consumption on CO2 emissions in 20 Organization of Islamic Cooperation (OIC) nations rather

than total energy consumption. The major finding is that overall national productivity correlates to greater environmental degradation in the long run. In the near run, however, the overall national output does not affect CO2 emissions. The data also imply that while the population can lower CO2 emissions in the short run, it has a little long-term effect. The environmental impact of oil use is greater than that of gas consumption.

1.3 Methods and Data

This study will be designed to use data from the last 30 years from 1990 to 2019. Panel data from the World Development Indicators will be obtained for this project. Following data collection, variables will be checked for unit root using panel unit root testing, and a strategy will be chosen based on the sequence of integration.

1.3.1 Specification of the model

By using the Panel ARDL method panel data was utilized to inspect the connection between CO2 emissions, energy consumption, population, and economic growth. The basic model was:

Carbon dioxide emissions = f (Population, Energy Consumption, Economic Growth)

$$CO2 = f\ (POP, ENR, GDP) \qquad (i)$$

To test the hypothesis empirically model can be specified based on the work of Mansoor and Sultana, (2018) as follows:

$$CO2 = \beta_0 + \beta_1 POP + \beta_2\ ENR + \beta_3 GDP + \mu \quad (ii)$$

1.3.2 Measurement of variables

Table 1: Measurement of Variables

Variables	Measurement	Source	Nature
CO2	CO2 emissions (kg per 2010 US$ of GDP)	WDI	Carbon dioxide emissions are those caused by the combustion of fossil fuels and the production of cement. They include carbon dioxide emitted from the combustion of solid, liquid, and gas fuels, as well as gas flaring.
POP	Population growth (annual %)	WDI	The average annual rate of change in population size for a specific country, territory, or geographical area over a given period. It is commonly expressed as a ratio of the annual increase in population size to the total population for that year, multiplied by 100.
ENR	Energy use (kg of oil equivalent per capita)	WDI	The unit of measurement is the kg of oil equivalent (kgoe), which is a normalized unit of energy. It is about the amount of energy that may be extracted from one kilogram of crude oil (41868 kilojoules).
GDP	GDP per capita (constant 2010 US$)	WDI	Gross domestic product per capita is GDP separated by the midyear population. Gross domestic product is the amount of gross value added by all producers and residents in the economy in addition to any taxes and minus any subsidies excluded from the actual value of the products.

1.3.3 Methodology

To check whether the variables are stationary or not, unit root testing is used. As the data consist of a panel of 3 emerging South Asian Economies, panel unit root testing is used. Panel unit root testing is more significant than the Simple time series unit root tests. The ADF - Fisher Chi-square unit root test is utilized to identify the order of integration. After analyzing the level of stationarity, the PMG estimator can exhibit heterogeneous short-run estimations of the intercept, adjustment speed, and error variance. The long-run slope coefficient is constrained to be homogeneous. The advantage of utilizing this strategy is that it is more efficient and consistent in capturing the existence of a long-run relationship. Nonetheless, the coefficient of error correction must be lower than 2 and negative. Furthermore, the key assumption that estimation consistency is required can result in no serial correlation in the residual of the error correction model, resulting inhomogeneity in the explanatory variables. Once the lags (p, q) for both the dependent (p) and independent (q) variables are included, the requirements can be met. This approach requires high T and N sizes, and T must be larger than N (Pesaran et al, 1999).PMG to determine the long-run relationship in models is composed as follows:

$$CO2_{it} = \mu_i + \sum_{j=1}^{p} \lambda_{ij}\, CO2_{i,t-j} + \sum_{j=1}^{q} \delta_{ij} POP_{i,t-j} + \sum_{j=1}^{q} \delta_{ij} ENR_{i,t-j} + \sum_{j=1}^{q} \delta_{ij} GDP_{i,t-j} + \varepsilon_{it} \quad \text{(iii)}$$

Where nations (1, 2, 3) are addressed by i, the year (1990–2019) is addressed by t, the ideal delay is addressed by j and a proper impact is addressed by μ_i. The short-run relationship with error correction models is composed as follows:

$$CO2_{it} = \mu_i + \varphi_i\left(CO2_{it-1} - \lambda_1\, POP_{i,t} - \lambda_2\, ENR_{i,t} - \lambda_3\, GDP_{i,t}\right) + \sum_{j=1}^{p} \lambda_{ij}\, CO2_{i,t-j} + \sum_{j=1}^{q} \delta_{ij} POP_{i,t-j} + \sum_{j=1}^{q} \delta_{ij} ENR_{i,t-j} + \sum_{j=1}^{q} \delta_{ij} GDP_{i,t-j} + \mu_{it} \quad \text{(iv)}$$

4. Estimation and Results

Table 2: Unit root Testing

Variables	At level			At 1st difference		Conclusion
	None	Intercept	Intercepts and trends	None	Intercept	
CO2	4.01536	4.47259	5.09885	74.1754***		I(1)
POP	36.6344***					I(0)
ENR	0.11523	2.78472	0.51223	17.4402***		I(1)
GDP	0.29210	0.09022	2.28319	9.19564	10.7550*	I(1)
Note: ***, ** and * shows importance level at 1%, 5%, and 10% separately.						

Many economic variables are non-stationary normally, and to check whether the problem of unit root exists, all variables are tested at the level and first difference using the ADF Fisher Chi-Square test. The result shows that CO_2, Energy consumption, and GDP are non-stationary at the level while the population is stationary at the level. This means that CO_2 emissions, energy consumption, and GDP confirmed that they are first differenced stationary.

Table 3: Long-run results

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
ENR	0.1390	0.0149	9.3288	0.0000
GDP	-0.0502	0.0082	-6.1219	0.0000
POP	-0.1837	0.0311	-5.8932	0.0000

Long run results of the model are described in table 3 and it indicates that energy consumption (ENR) is statistically significant at 1% the coefficient shows if the energy consumption is increased by 1% then the CO_2 emission will be increased by 13% in the long run. This shows that there is a positive relationship between energy consumption and CO_2 emissions in the economies of Pakistan, India, and Bangladesh. The result is linked with the previous studies of Abdollahi (2020), Saidi and Hammami (2015), Khan et al (2019), Al-mulali and Sab (2012) which also stated that an increment in energy consumption causes environmental degradation.

The GDP per capita is statistically significant and the coefficient shows if the GDP per capita is increased by 1% then the CO2 will be decreased by 5% in the long run which means GDP per capita has a negative relationship with CO_2 emissions for these three economies. These results are consistent with the previous study of Abdollahi (2020) as CO_2 emissions decrease the environmental quality, it might make a negative impact on economic growth by affecting human well-being which would diminish productivity and damage production in the long run. While population (POP) has a significant relation with carbon emissions as if there is an increase in population by 1%, there will be 18.37% decrease in CO_2. So there is a negative relationship between population (POP) and CO_2 emissions for Pakistan, India, and Bangladesh in the long run. As these three economies are included in the top most populous countries of the world, this negative relationship may be because to incorporate more people land resources are utilized more for non-productive uses rather than industrial use, due to which emission of carbon and other gases can be declined.

Table 4: Short Run Results

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
COINTEQ01	-0.753647	0.408034	-1.847021	0.0709
D(ENR)	0.002486	0.001476	1.685076	0.0985
D(ENR(-1))	0.001065	0.000399	2.666384	0.0104
D(GDP)	-0.001471	0.000514	-2.863074	0.0062
D(GDP(-1))	0.000016	0.000831	0.019301	0.9847
D(POP)	1.203448	1.487075	0.809272	0.4224
D(POP(-1))	-0.605383	1.155798	-0.523779	0.6028
C	0.914639	0.505737	1.808527	0.0768

Short-run results are depicted in table 4 above and the error correction term shows the speed of convergence of an economy when it came across any shock in the short run. That's why it is also called the stability coefficient which describes the stability of the economy in the short run. The value of this coefficient is -0.7536, which reveals that the speed of adjustment toward the equilibrium is stable over a while. The coefficient of energy consumption (ENR) is statistically significant which shows 1 percent increase in energy consumption will bring a 0.24% increase in CO_2 emission in the short run because they are positively related. The result is consistent with the previous studies of Al-mulali and Sab (2012), Jamel and Derbali (2016), and Baig and Baig (2014). It means that an increase in energy consumption is a risk to deteriorate environmental quality because it will increase CO_2 emission. Similarly, the GDP per capita has negative relation with CO_2 emission in the short run as a 1 percent increase in GDP per capita will bring -a 0.1471% decrease in CO_2 emission. This means that as countries evolved with time, environmental degradation is being affected that much in the initial stages of development. These results are consistent with the previous studies of Mansoor and Sultana (2018), Zaman et al (2015), Aye and Edoja (2017), and Hassan and Nosheen (2018).

Country Effects in the Short run:

Table 5: In the case of Pakistan's Economy

Variable	Coefficient	Std. Error	t-Statistic	Prob. *
COINTEQ01	-1.568346	0.025007	-62.71615	0.0000
D(ENR)	-0.000460	0.00000026	-1767.704	0.0000
D(ENR(-1))	0.001364	0.000000157	8690.639	0.0000
D(GDP)	-0.000444	0.0000000548	-8099.048	0.0000
D(GDP(-1))	-0.001265	0.0000000592	-21349.13	0.0000
D(POP)	-0.155798	0.015587	-9.995362	0.0021
D(POP(-1))	0.553259	0.047448	11.66040	0.0014
C	1.922103	0.155808	12.33635	0.0011

The error correction term confirmed the model is convergent toward its equilibrium whenever it is disturbed, as its coefficient value is -1.568, which reveals that the speed of adjustment toward the equilibrium is stable over some time in the case of Pakistan's economy. The energy consumption (ENR) in Pakistan is statistically significant at 1% and it shows if the energy consumption increases by 1% in Pakistan then the CO_2 will be decreased by -0.046% in the short run. These results are consistent with the previous study of Munir and Khan (2014) which confirmed energy consumption negatively affects CO_2 emission. Results support the inverted U-shaped environmental Kuznets curve for Pakistan. The GDP per capita also has a significant negative relation with the dependent variable as it shows that if there is a 1 percent increase in GDP per capita then there will be a -0.044% decrease in CO_2 emission. These results are consistent with the previous studies of Mansoor and Sultana (2018), Zaman et al (2015), Aye and Edoja (2017), and Hassan and Nosheen (2018) which means Pakistan has developed economically in such a way that it developed more, the lesser will be the carbon emissions. In

the case of the Pakistani economy, population (POP) is statistically significant and it shows that if the population is increasing by 1% then the CO_2 will be decreased by -15.57% in the short run. The result is consistent with the previous studies of Mansoor and Sultana (2018), Bulut et al (2017), Aye and Edoja (2017), and Yeh and Liao (2017) which indicate that as the Pakistani population grows bigger, it is not dangerous for the environmental degradation.

Table 6: In the case of the Indian Economy

Variable	Coefficient	Std. Error	t-Statistic	Prob. *
COINTEQ01	-0.305385	0.008265	-36.95037	0.0000
D(ENR)	0.003814	0.000000325	11748.74	0.0000
D(ENR(-1))	0.001557	0.000000552	2821.135	0.0000
D(GDP)	-0.002017	0.0000000767	-26309.40	0.0000
D(GDP(-1))	-0.000262	0.0000000835	-3135.573	0.0000
D(POP)	4.174036	1.380814	3.022881	0.0566
D(POP(-1))	-2.916977	1.112531	-2.621930	0.0789
C	0.488826	0.023888	20.46282	0.0003

The error correction term confirmed that this model is convergent for Indian Economy as well, as the speed of adjustment towards the equilibrium is stable over some time. Energy consumption (ENR) in India has a significant and positive relationship with environmental degradation as a 1 percent increase in energy consumption will yield a 0.38% increase in CO_2 emission in the air, which cause severe environmental hazards to the Indian economy. Similarly, the coefficient of energy consumption (ENR) is also positively related to CO_2 emission which means energy consumption is directly proportional to the omission of carbon dioxide. These results are consistent with the previous studies of Yang and Zhao (2014), Aye and Edoja (2017), Jamel and Derbali (2016) because more the utilization of energy will produce more CO_2 emission. Similarly, population (POP) is also significantly and positively related to CO_2 emission as 1% increase in CO2 will bring a 4.17% increase in environmental degradation in the short run in India. These results are consistent with the previous studies of Aye and Edoja (2017), Ohlan (2015) which means rapid population growth leads to environmental change. However, The GDP per capita has significant but negative relation with CO_2 emission if there is a 1% increase in GDP per capita then there will be a -0.20% decrease in CO_2 emission. These results are consistent with the previous studies of Aye and Edoja (2017) and Abdollahi(2020) which show that economic growth has a negative effect on CO2 emission when the economy is in a low-growth regime.

Table 7: In the case of Bangladesh

Variable	Coefficient	Std. Error	t-Statistic	Prob. *
COINTEQ01	-0.387209	0.027680	-13.98894	0.0008
D(ENR)	0.004105	0.000000755	5434.992	0.0000
D(ENR(-1))	0.000274	0.000000637	429.6712	0.0000
D(GDP)	-0.001953	0.000000391	-4996.965	0.0000
D(GDP(-1))	0.001574	0.0000004	3936.750	0.0000
D(POP)	-0.407893	0.044979	-9.068432	0.0028
D(POP(-1))	0.547570	0.059391	9.219754	0.0027
C	0.332988	0.019391	17.17255	0.0004

The error correction term for Bangladesh is also convergent after facing a shock in the short run, as its coefficient is -0.387, which reveals that the speed of adjustment towards the equilibrium is stable over a period of time. Energy consumption (ENR) in Bangladesh is positively and significantly affecting environmental degradation as a 1% increase in energy consumption will increase CO_2 emissions by 0.410% in the short run. On the contrary, GDP per capita is also significant and the coefficient of GDP per capita shows a decrease of -0.1953% in CO_2 emission. These results are consistent with the previous studies of Ghosh et al (2014) and Abdollahi(2020). As CO_2 emissions reduce the environmental quality, it may cause a negative effect on economic growth by influencing human health which would decrease productivity. Similarly, population (POP) is significant but negatively impacting CO_2 emission as a 1 percent increase in population will decrease CO_2 emission by -0.40% in the short run. The result is linked with the previous study of Anser et al (2019) because high population growth leads to increase CO_2 emissions in the country.

5. Conclusion

For a period of 30 years ranging from 1990 to 2019, the effect of Economic Growth, Population and Energy Consumption on environmental degradation in three emerging economies of South Asia; Pakistan, India, and Bangladesh. The results of Panel ARDL show that there is a positive connection between energy consumption and CO_2 emission in the long run. There is a negative connection between GDP per capita and population with CO_2 emission which implies that GDP per capita and populace (POP) are not serving as a cause of environmental degradation. Whereas there is a positive relation between energy consumption and population with CO_2 emission in the short run.As Environmental degradation has an adverse effect on social life, leading to extreme events such as heavy rainfall, extreme temperature, and extreme floods with an increase in CO_2 emission. It is recommended that these countries can invest in modern technologies to replace non-renewable and fossil fuels with clean and green fuels. Therefore, investing in research and development for clean energy is an inseparable part of controlling CO2 emissions. Furthermore, governments may take steps to achieve sustainable economic growth by imposing a tax on emissions. Sustainable development is a triangle of energy, environment, and economy that necessitates Pakistan, India, and Bangladesh's complete transition to renewable energy which is

a very crucial indicator for the sustainable future of the countries. This work can be extended to the whole South Asian region along with adding a few more variables as well.

References

Abdollahi, H. (2020). Investigating energy use: Environment pollution and economic growth in developing countries. *Environmental and Climate Technologies, 24*(1), 275-293. https://sciendo.com/pdf/10.2478/rtuect-2020-0016

Akpan, G. E., & Akpan, U. F. (2012). Electricity consumption carbon emissions and economic growth in Nigeria. *International Journal of Energy Economics and Policy, 2*(4), 292-306. https://doi.org/10.2478/rtuect-2020-0016

Alam, H. J., Begum, M. J., & Buysse, I. A. (2012). Energy consumption, carbon emissions and economic growth nexus in Bangladesh: Cointegration and dynamic causality analysis. *Energy Policy, 45*, 217-225. DOI: 10.1016/j.enpol.2012.02.022

Alam, S., Fatima, A., & Butt, M. S. (2007). Sustainable development in Pakistan in the context of energy consumption demand and environmental degradation. *Journal of Asian Economics*, 18, 825–837. DOI:10.1016/j.asieco.2007.07.005

Ali, M., Raza, S. A., & Khamis, B. (2020). Environmental degradation, economic growth and energy innovation: evidence from European countries. *Environmental Science and Pollution Research*, 27(10), 1-11. DOI:10.1007/s11356-020-09142-z

Al-mulali, U., & Sab, C. N. B. C. (2012). The impact of energy consumption and CO2 emission on the economic growth and financial development in the Sub Saharan African countries. *Energy*, 39(1), 180–186. https://doi.org/10.1016/j.energy.2012.01.032

Anser, M. K., Alharth, M., Aziz, B., & Wasim, S. (2019). Impact of urbanization, economic growth and population size on residential carbon emissions in the SAARC countries. Clean Technologies and Environmental Policy, 26(13), 13453–13463. https://www.springerprofessional.de/en/impact-of-urbanization-economic-growth-and-population-size-on-re/17798458

Aye, G.C., & Edoja, P.E. (2017). Effect of economic growth on CO2 emission in developing countries: Evidence from a dynamic panel threshold model. *Cogent Economics & Finance*, 5(1), 1-22. https://doi.org/10.1080/23322039.2017.1379239

Baig, M. A., & Baig, M. A. (2014). Impact of CO2 Emissions: Evidence from Pakistan. *Institute of Business Management (IoBM) Karachi Pakistan*, 1-13. https://www.researchgate.net/publication/260172168_Impact_of_CO2_Emissions_Evidence_from_Pakistan

Ghosh, B. C., Alam, K. J., & Osmani, A. G. (2014). Economic growth, CO2 emissions and energy consumption: The case of Bangladesh. *International Journal of Business and Economics Research*,3(6), 220-227. https://dergipark.org.tr/en/download/article-file/361332

Haseeb, M., & Azam, M. (2015). Energy Consumption, Economic Growth and CO2 Emission Nexus in Pakistan. *Asian Journal of Applied Sciences*, 8(1), 27-36. DOI: 10.3923/ajaps.2015.27.36

Hassan, S.A., &Nosheen, M. (2018). The Impact of Air Transportation on Carbon Dioxide, Methane and Nitrous Oxide Emissions in Pakistan: Evidence from ARDL Modelling Approach. *International Journal of Innovation and Economic Development*, 3(6), 7-32. DOI: 10.18775/ijied.1849-7551-7020.2015.36.2001

Islam, Z., Ahmed, Z., Saifullah, K., Huda, S. N., & Al-Islam, S. M. (2017). CO2 Emission, Energy Consumption and Economic Development: A Case of Bangladesh. *Journal of Asian Finance, Economics and Business*, 4(4), 61-66. https://koreascience.kr/article/JAKO201716463831025 page

Jamel, L., &Derbali, A. (2016). Do energy consumption and economic growth lead to environmental degradation? Evidence from Asian economies. *Cogent Economics & Finance*, 4(1), 1-19. https://doi.org/10.1080/23322039.2016.1170653

Jebli, M. B., & Youssef, S. B. (2013). The environmental Kuznets curve, economic growth, renewable and non-renewable energy and trade in Tunisia. *Munich Personal RePEc Archive*, 52127, 1-21. DOI: 10.1016/j.rser.2015.02.049

Khan, M. A., Khan, M. Z., Zaman, K., Khan, M. M., & Zahoor, H. (2013). Causal links between greenhouse gas emissions, economic growth and energy consumption in Pakistan: A fatal disorder of society. *Renewable and Sustainable Energy Reviews*, 25, 166–176. DOI: 10.1016/j.rser.2013.04.002

Khan, M. K., Khan, M. I., &Rehan, M. (2020). The relationship between energy consumption, economic growth and carbon dioxide emissions in Pakistan. *Financial Innovation*, 6(1), 2-13. https://jfin-swufe.springeropen.com/articles/10.1186/s40854-019-0162-0

Khan, S., Peng, Z., & Li, Y. (2019). Energy consumption, environmental degradation, economic growth and financial development in globe: Dynamic simultaneous equations panel analysis. *Energy Reports*, 5, 1089-1102. https://doi.org/10.1016/j.egyr.2019.08.004

Liu, X. (2005). Explaining the relationship between CO2 emissions and national income: The role of energy consumption. *Economics Letters*, 87(3), 325-328. http://taskin.bilkent.edu.tr/teach/302_11/liu_2005.pdf

Mansoor, M., & Sultana, B. (2018). Impact of Population, GDP and Energy Consumption on Carbon Emissions: Evidence from Pakistan Using an Analytic Tool IPAT. *Asian Journal of Economics and Empirical Research*, 5(2), 183-190. DOI:10.20448/journal.501.2018.52.183.190

Martínez-Zarzoso, I., Bengochea-Morancho, A., & Morales-Lage, R. (2006). The Impact of Population on CO2 Emissions: Evidence from European Countries. 2-28. https://link.springer.com/article/10.1007/s10640-007-9096-5

Menyah, K., &Wolde-Rufael, Y. (2010). Energy consumption, pollutant emissions and economic growth in South Africa. *Energy Economics*, 32(6), 1374-1382. http://www.sciencedirect.com/science/article/pii/S0140-9883(10)00123-4

Mikayilov, J. I., Galeotti, M., &Hasanov, F. J. (2018). The Impact of Economic Growth on CO2 Emissions in Azerbaijan. *Center for Research on Energy and Environmental Economics and Policy*, 102, 1-32. https://doi.org/10.1016/j.jclepro.2018.06.269

Mohiuddin, O., Asumadu-Sarkodie, S., & Obaidullah, M. (2016). The relationship between carbon dioxide emissions, energy consumption, and GDP: A recent evidence from Pakistan. *Cogent Engineering*, 3, 2-16. https://doi.org/10.1080/23311916.2016.1210491

Naseem, I., & Khan, J. (2015). Impact of Energy Crisis on Economic Growth of Pakistan. *International Journal of African and Asian Studies* 7, 33-43. https://core.ac.uk/download/pdf/234689844.pdf

Ohlan, R. (2015). The impact of population density, energy consumption, economic growth and trade openness on CO2 emissions in India. *Natural Hazards*, 79(2), 1409-1428. https://link.springer.com/article/10.1007/s11069-015-1898-0

Rahman, M. M., Saidi, K., &Mbarek, M. B. (2020). Economic growth in South Asia: the role of CO2 emissions, population density and trade openness. *Heliyon*, 6, 1-9. DOI: 10.1016/j.heliyon.2020.e03903

Saidi, K., & Hammami, S. (2015). The impact of CO2 emissions and economic growth on energy consumption in 58 countries. *Energy Reports*, 1, 62–70. https://doi.org/10.1016/j.egyr.2015.01.003

Sehrawat, M., Giri, A. K., & Mohapatra, G. (2015). The impact of financial development, economic growth and energy consumption on environmental degradation Evidence from India. *Management of Environmental Quality: An International Journal*, 26(5), 666-682. DOI:10.1108/MEQ-05-2014-0063

Shaari, M. S., Karim, Z. A., & Abidin, N. Z. (2020). The Effects of Energy Consumption and National Output on CO2 Emissions: New Evidence from OIC Countries Using a Panel ARDL Analysis. *Sustainability*, 12, 02-12. https://doi.org/10.3390/su12083312

Sheikh, M. A. (2010). Energy and renewable energy scenario of Pakistan. *Renewable and Sustainable Energy Reviews*, 14(1), 354-363. https://doi.org/10.1016/j.rser.2009.07.037

Tiwari, A. K. (2011). A structural VAR analysis of renewable energy consumption, real GDP and CO2 emissions: evidence from India. *Economics Bulletin*, 31(2), 1793-1806. https://ideas.repec.org/a/ebl/ecbull/eb-10-00774.html

Yang, Z., & Zhao, Y. (2014), Energy consumption, carbon emissions and economic growth in India: Evidence from directed acyclic graphs. *Economic Modelling*, 38, 533-540. DOI: 10.1016/j.econmod.2014.01.030

Yeh, J.-C., & Liao, C.-H. (2017). Impact of population and economic growth on carbon emissions in Taiwan using an analytic tool STIRPAT. *Sustainable Environment Research*, 27(1), 41-48. https://doi.org/10.1016/j.serj.2016.10.001

Zaman, K., Hassan S. A., & Gul, S. (2015). The relationship between growth-inequality-poverty triangle and environmental degradation: Unveiling the reality. *Arab Economics and Business Journal*, 10(1), 57-71. https://doi.org/10.1016/j.aebj.2014.05.007