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Does Forestry Resolve the Dilemma of Environmental Degradation or Economic Development? A Case for Green Economic Growth

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On the one hand, global warming and climate change pose an existential crisis while on the other hand, the basic economic problem of scarcity forces everyone to look for ways to increase their economic growth. Therefore, this paper explores ways of attaining economic growth without compromising the environment. The study applies system GMM estimation methodology for the period of 1991-2015 on 6 Latin American, two Eastern European, and one Asian emerging economies which are also in the top 120 environmentally affected countries list. The results show that measures leading to economic growth, such as manufacturing value-added, electricity production, and urbanization also lead to environmental degradation. While trade openness and forest cover decrease CO2 emissions. The paper concludes with policy recommendations that trade and afforestation are two ways that enable economic growth without affecting environmental quality.

Key words: *Environmental degradation, Economic growth, Sustainable development, Afforestation, Deforestation.*

JEL Classification: O44, Q01.Q56, R11

Introduction

Air pollution is the leading hazard to everyone's health. According to the Institute for Health Metrics, deaths due to airborne pollutants comprised two-thirds of all deaths in 2016. Environmental degradation is a global phenomenon with it being direr in emerging economies. Global warming and climate change pose an existential crisis for humanity. Such disturbances cause frequent floods, prolonged droughts, and heavy rains. These environmental changes have posed not only colossal threats such as scarcity of fresh water, food, and clean air but have also advanced the issues related to human security such as displacement, health, and migration (Warner *et al*, 2010). Therefore, it is the greatest challenge faced by humanity that requires imminent action.

A primary factor behind environmental degradation is Carbon dioxide (CO_2) emission which has been increasing at an alarming rate. During the industrial revolution, developed countries were responsible for most of the CO_2 emissions. However, current and future emissions are going to be driven mainly by emerging economies due to their dependence on fossil fuel as an energy source. Emerging economies have high pollution rates in the early development stages because they are in transition with dependence on obsolete production facilities. Moreover, foreign direct investment may be exploiting the natural resources of the country by focusing on cost minimization only (Abbes et al., 2015).

Conversely, the basic economic problem of scarcity forces every nation to look for ways to boost its economic growth. Economic growth, backed by industrialization leads to employment, higher incomes, better standards of living, and more satisfying wants. Despite its importance, economic growth deteriorates the environment and thus adds to global warming. As many developing countries are experiencing rapid economic growth there will be large carbon emissions which will eventually lead to more pollution, temperature rises, and adverse climate changes (Ahmed & Long, 2012). Furthermore, economic growth induces higher demands of energy which in turn is the leading reason for environmental degradation (Saidi & Hammami, 2016).

However, neither economic growth nor environment can be compromised. Therefore, the question before economists and policymakers, especially in developing and emerging economies is how to achieve economic growth without environmental degradation. We believe that the answer lies in planting more trees and saving the existing, thus increasing the forest cover of the earth. Forests are considered the most pivotal source to control the ecosystem and are weighed natural filters for the absorption of carbon dioxide in the atmosphere (Negar and Jean 2014). According to Franklin D. Roosevelt "A nation that destroys its soil, destroys itself. Forests are the lungs of our land, purifying the air and giving

fresh strength to our people". However, trees are disappearing at an alarming rate. According to the World Bank, 1.3 million square kilometers of the forest has been lost.

This study contributes by providing a solution to growth – environment trade-off. We put forward a simple solution to make it possible to grow economically without degrading the environment. We test the effectiveness of our proposed solution by examining the nexus between environmental deterioration and economic development in nine emerging economies that according to the environmental performance index (EPI) report of 2018 lie amongst the top 120 environmentally affected countries. The EPI ranks 180 countries based on 24 performance metrics that encompass ecosystem vitality and environmental health. This score identifies the leaders and laggards in environmental policy implementation at the national level. From this list, we have selected countries that lie between this continuum. That is, neither are they leaders nor are they laggards. The reason being that leaders already have strong environmental policies in place and laggards are least committed to protecting the environment, they are tangled with broader challenges such as civil unrest and weak governance. Therefore, we have focused on a sample of countries that are struggling to balance both economic growth and environmental sustainability.

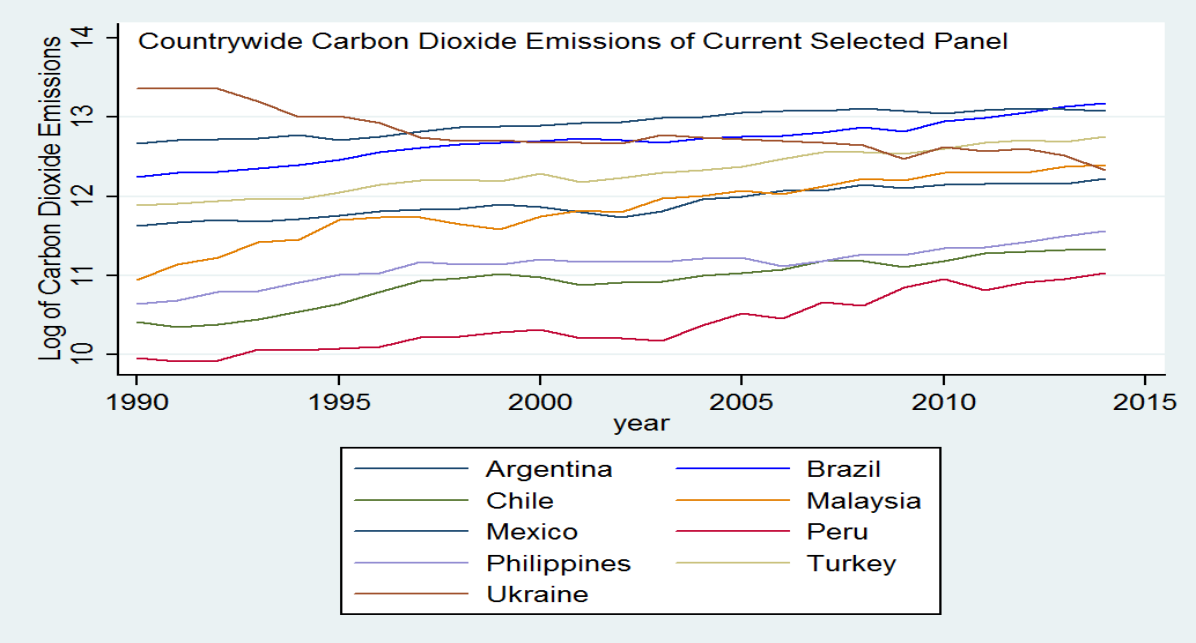
The current study takes a sample of six Latin American countries namely, Argentina, Brazil, Chile, Mexico, Peru, and the Philippines; two Eastern European countries namely, Turkey and Ukraine, and one Asian country which is Malaysia. Moreover, as can be seen from figure 1, all countries except Ukraine have an increasing trend of CO2 emissions. Nonetheless, Ukraine cannot be ignored because it has one of the highest CO2 emissions per capita, that is, 5.22 tons per person (Worldometers, 2019). Furthermore, the declining trend is not due to better policy implementation but rather due to economic crisis and military invasion in the country that had a detrimental impact on the country's production. With the situation now under control, it is predicted that the country's CO2 emissions will rise again in the coming years (Menr, 2019).

Table 1: Environmental Performance Index Rankings

	Rank	**Score**
Argentina	74	59.30
Brazil	69	60.70
Chile	84	57.49
Mexico	72	59.69
Peru	64	61.92
Philippines	82	57.65
Turkey	108	52.96
Ukraine	109	52.87
Malaysia	75	59.22

Note: The rank is from 1 to 180, with 1 being least committed in environment protection and 180 being most committed.
Source: Environmental performance index (EPI) report of 2018

Figure 1. CO_2 Emissions



Source: Authors' estimation

Secondly, these countries are selected because according to Morgan Stanley Capital International (MSCI) annual market classification review 2019, except Ukraine, all of the countries are classified as emerging economies. Ukraine has been classified as a frontier and stand-alone market. The role of emerging and frontier economies is significant because of their rapid growth, industrialization policies, and expected bright future (Carrasco and Williams, 2012). This topic is more relevant for emerging countries that are currently in a developmental transition phase. Lastly, limited data availability is another reason due to which we had to restrict our sample to the aforementioned countries.

The global increase in environmental crisis has brought economic activity under scrutiny. However, economists continue to believe that economic growth is inevitable for poverty elimination and achieving higher standards of living. Therefore, there is a need to look for ways in which high economic growth can be attained while protecting the environment. Thus, this study will have policy implications for all countries that are struggling to achieve economic growth with no or minimum environmental damage.

The rest of the paper is organized as follows. Section 2 discusses the theoretical development of the topic. Section 3 describes the data and methodology. Section 4 gives results and

discusses the outcome of the model. Finally, Section 5 sums up the findings and discusses some policy implications.

Literature Review

Escalating environmental deterioration and its repercussions have led to increased scholarly endeavors that investigate the determinants behind it. Existing literature shows that there has been a trend to determine environmental degradation and climate change from various factors including economic growth, deforestation, trade, energy, urban population, and financial development; among others.

Determining environmental deterioration by economic growth is longstanding. The Environmental Kuznets curve (EKC) was advanced in a seminal paper by Grossman and Krueger in 1991. The EKC puts forward that economic growth and pollution have an inverted U-shape relationship which implies that CO2 emissions initially increase due to economic growth but as the economy matures, emissions decline. The authors argued that due to an increase in income levels, individuals demand improvements in air quality and resource availability permits the required advancement in technology. Many studies have validated the EKC hypothesis and have confirmed the U shape curve existence (Zarzoso & Morancho, 2004). However, some studies also report to the contrary. For example, Giovanis (2013) used a dynamic panel with effects and reported that the EKC curve did not exist in Great Britain.
Earlier literature can be separated into two strands, one collection focuses on individual countries, and the other uses a panel of countries. Focusing, on the later, many studies have validated the EKC hypothesis via a group of countries. For instance; Lean and Smyth (2010) used a panel vector error correction model on five ASEAN countries and reported pollution, energy, and economic growth have a unidirectional causality. Likewise, Apergis et al., (2010) used the same technique on a group of 19 developed and developing countries with two added variables of nuclear and renewable energy consumption. The results show that in the short run CO2 emissions are reduced by nuclear energy but not by renewable energy sources.
Furthermore, many scholars have studied the topic with individual countries. For example, Eddine Chebbi (2010) and Chang (2010) used Tunisian and Chinese time-series data to study the causal link between economic growth, CO2 emissions, and energy. By applying multivariate causality tests, the study's revealed that economic growth increases energy consumption that leads to CO2 emissions. In the case of Bangladesh, Alam et al., (2012) applied ARDL bounds testing and found a positive relationship between the aforementioned three variables. Similarly, Hatzigeorgiou et al. (2011) applied the VECM Granger causality test on Greece and reported similar results.

Therefore, many scholars have found a positive association between energy consumption and economic growth. Lee and Chang (2008) studied the relationship for 16 Asian countries

during the 1971–2002 period using panel-based error correction models. They found a long-run positive association between the variables. Furthermore, researchers are of the view that growth driven factors are responsible for the current status of degradation. Awan (2013) reported that industrialization is one of the key factors of economic development but it is also responsible for declining the quality of the environment. Any pollution-intensive industry creates a high level of risk for the inhabitants where the industry is situated. Likewise, Shahbaz et al. (2012) found that in short and long-run CO2 emissions are increased because of energy consumption, and in the long run, trade decreases the CO2 emissions.

Recently, scholars have shifted their attention to other factors that may have an impact on environmental degradation. Tamazian et al. (2010) studied the impact of financial and institutional variables on CO2 emissions of 24 transition countries. They used generalized method of moments (GMM) estimation and found openness to trade without a strong institutional framework is detrimental for the environment, Furthermore, Bhattacharyya and Ghoshal (2010) reported that high population densities strengthen the positive relationship between economic development and CO2 emissions.

Deforestation is another important factor that leads to environmental degradation. Forests are disappearing at an alarming rate causing global repercussions. Chaudhary (2016) reports that illegal encroachment of forest land and cutting of trees for agriculture, and construction purposes are causing severe climate changes. The average temperature level is increasing and there are delayed and irregular patterns of rainfalls followed by severe dry periods. As a result of these negative developments, we have been exposed to economic, food and health, environment, and political threats. Likewise, Fearnside (1997) conducted a descriptive study and concluded that different usage of the land, burning of wood, construction, and cattle and pasture were the main cause of deforestation. Furthermore, deforestation is responsible for the emission of greenhouse gas (GHGs) and hence is the main reason for climate change. However, he did not present any empirical evidence to support his findings.

From the existing review of literature, we can delineate that along with others, deforestation and economic growth have been studied separately as factors causing environmental degradation. To the best of our knowledge, there is no prior literature that combines both, economic growth and forestry into a model to investigate whether economic growth can be achieved without degrading the environment. Therefore, in this paper, we study whether through the forest sector we can simultaneously achieve economic growth and environmental restoration. Furthermore, from the previous studies we can also see that majority of the papers have either used granger causality or error correction models, there was only one paper (Tamazian et al., 2010) that has used GMM. Therefore, we add to the existing literature by using the System GMM model to study the nexus between economic degradation and economic development.

Hypothesis Development

Based on the aforementioned literature review, energy consumption increases CO2 emissions. Moreover, electricity production can be divided into two groups, non-renewable (Minerals, coal, oil, and gas) and renewable production (Nuclear, wind, solar, hydropower, etc.). Nonrenewable electricity production is considered a factor of environmental degradation and therefore we hypothesize that nonrenewable energy production will increase CO2 levels. Furthermore, industrialization is an important factor in both, economic development and environmental degradation. Any pollution-intensive industry creates a high level of risk for the inhabitants where the industry is situated.

According to classical economists, a high growth rate of the population is responsible for the depletion of natural resources. In the pursuit to provide a higher living standard, we are exhausting our resources that are already scarce in quantity. In the same way, according to neoclassical economists, a high population might be worse for environmental quality in the presence of market distortions. An increase in the urban population, especially, demands high living standards and puts pressure on natural resources which leads to resource depletion (Carole L Jolly, 1994). Moreover, the urban population leads to more quantity of garbage, construction of houses and roads, etc. which leads to environmental degradation.

Furthermore, globalization has also been found to have an impact on both economic growth and environmental degradation. Shafik (1994) proposed that the more open an economy is, the cleaner will be their production processes. The author asserts that competition will lead to investments in greener and advanced technologies that meet international standards. However, others find the contrary results. Nuemayer (2000) argues that globalization fuels economic growth but at the cost of the environment. Similarly, Angelsen & Kaimowitz (1999) report that economic liberalization causes deforestation which in turn leads to pollution. Therefore, we hypothesize that trade will have a significant impact on CO2 levels.
All of the above-discussed factors are considered as the factors responsible for environmental degradation. The solution to this problem lies in increasing the forest cover of the land. Forests regulate the global climate and are necessary for environmental sustainability. We can define the forest as the area under the trees which is more than 0.5 hectares. Furthermore, we can divide forests into four major categories namely, tropical, subtropical, temperate, and boreal forests. All types of forests play their social, environmental, and economic role in society. They provide basic ecosystem services such as regulation of water flow, improved rain patterns, absorption of carbon dioxide, and releasing oxygen (FAO, 2017). Furthermore, forests help in reducing poverty because the forest sector is a source of income for 1.6 billion people. Finally, it is home to different types of plants, insects, and animals and therefore essential for preserving biodiversity (United Nations, 2015).

In sum, economic growth, population, energy, and globalization are degrading the environment. Whereas, forests improve environmental quality along with providing food, income, shelter. Thus, for sustainable development understanding how changes in forest area impact the environment is of paramount importance.

Data, Model and Estimation Technique

The current study collected the annual data on carbon dioxide emissions, forest area, manufacturing value-added, urban population, electricity production from coal and oil as a percentage of total electricity production, and trade openness as the sum of imports and exports of 6 Latin American countries namely, Argentina, Brazil, Chile, Mexico, Peru, Philippines, two Eastern European countries namely, Turkey and Ukraine, and one Asian country which is Malaysia. All these countries are emerging economies and also the part of the list of top 120 environmentally degraded economies. Data covers the time span from 1991 to 2015.

Table 2: Description of Variables

Variable	Proxy	Definition
Environmental degradation (**CO**)	Natural log of CO2 emissions	CO2 emissions kg per person 2010 US$ of GDP
Forest Area (**FA**)	Natural log of Forest Area	The area in million hectares
Trade (TRADE)	the sum of exports and imports of goods and services	Percentage of GDP
Industrialization (MFVA)	The growth rate of the Manufacturing sector	The growth rate of value-added in the manufacturing sector in GDP.
Urbanization (UP)	The growth rate of Urban population	The growth rate of the urban population of male and female
Energy Production (EPC)	Electricity production in percentage	electricity production from oil, gas, and coal as a percentage of total production

Notes: The data on all the variables is taken from the World Bank.

While investigating the nexus between environmental degradation and economic growth, the paper adopts a long-balanced panel that can be estimated for empirical results with both, static and dynamic models. The difference between both models is that the former considers only current information, whereas, later considers past information of dependent and independent variables. Thus, it provides enriched information. The phenomenon of environmental degradation is not static and can be better analyzed after consideration of its dynamics. Therefore, the final dynamic model for empirical investigation is below:

$$CO_{2_{it}} = \beta_0 + \beta_1 CO_{2_{it-1}} + \beta_2 FA_{it} + \beta_2 MFVA_{it} + \beta_2 UP_{it} + \beta_2 EPC_{it} + \beta_2 TRADE_{it} + \varepsilon_{it} \quad (3.1)$$

Where ε is the Gaussian noise term. All variables are in log form except electricity production which is in percentage form, thus, coefficients will be elasticities. The equation (3.1) is estimated using the Arrelano-Bond estimator which is a generalized method of moments estimator introduced by Arrelano and Bond (1991). This is also known with the name of difference GMM because it takes the first difference of data before estimation. The augmented version of this estimator is called system GMM. This method has two variants first difference and second difference to tackle strong heterogeneity in the data but under the second difference, the estimated standard error could be downward biased (Blundell and Bond, 1998). To fix this problem Windmeijer (2000) derived a two-step covariance matrix and the xtabond2[1] command is a manual program that incorporates this information. There are also some other advantages of this command such as this command provides the value of the Sargan test for the validity of instrumental variables and the value of the Arrelano-Bond test for second-order autocorrelation. Therefore, this method is an appropriate one for the dynamic panel because it tackles all problems of a dynamic panel model.

Results and Discussion

This section first gives the correlation matrix (Table 3), followed by the estimation results of equation (Table 4) using system GMM, followed by the diagnostic tests. The robustness of the results is also checked using alternative estimation techniques.

Table 3: Correlation Matrix

OBSERVATIONS =225						
SERIES	**CO2**	**FA**	**MFVA**	**UP**	**EPC**	**Trade**
CO2	1					
FA	-0.1276	1				
MFVA	0.6455	0.1862	1			
UP	0.1469	-0.0439	0.225	1		
EPC	0.2282	-0.2334	0.025	-0.3475	1	
TRADE	-0.0243	0.2718	-0.2904	-0.4595	0.5851	1

Note: Authors' estimation

According to table 3, we can see that trade and forest areas have a negative correlation with

[1] David Roodman, 2003. "XTABOND2: Stata module to extend xtabond dynamic panel data estimator," Statistical Software Components S435901, Boston College Department of Economics

CO2 emissions whereas the other three variables have a positive association with carbon emissions. Moreover, from the table, we can discern that the model is free from the problem of multi-collinearity.

Table 4: Regression Results

REGRESSORS	CO_2	FA	MFVA	UP	EPC	TRADE	Const.
OUTPUT	.667*** [.0446]	-.008* [.0043]	.098*** [.0267]	.192*** [.0755]	.004*** [.0008]	-.001* [.0003]	-1.72** [.7916]

Values in square brackets are standard errors. ***, ** and * show significance at 1%, 5% and 10% respectively.

According to the results of system GMM (table 4), manufacturing value added (MFVA), energy production (EPC), and urban population (UP) have a statistically significant and positive impact on carbon dioxide emissions. This is in line with past literature that growth driven factors are responsible for this current status of degradation. Likewise, Awan (2013) reported that industrialization is one of the key factors of economic development but it is also responsible for declining the quality of the environment. Secondly, the paper used nonrenewable electricity production as a percentage of total electricity production and it is well documented that fossil fuels are the leading emitters of greenhouse gases, in particular carbon dioxide and methane. Lastly, dense human settlements in metropolitan cities have the highest pollution rates due to improper waste disposal, increased fuel, and electricity consumption which in turn leads to environmental degradation.

The results also show that trade openness (TRADE) and forest area (FA) have a statistically significant and negative impact on carbon dioxide emissions. Therefore, trade openness and afforestation are not only good sources of economic growth but also have a mitigating impact on environmental degradation generated by all of the other factors. Trade openness removes the price arbitrage in a country which leads to a free market economy and reduces the amount of CO2 emissions according to ACTs models (Thi Thanh Xuan Tran, 2016). Likewise, Shafik (1994) also proposed that the more open an economy, the cleaner will be their production processes. Moreover, a higher level of competition will also lead to investments in greener and advanced technologies that meet international standards.

Our GMM estimates report that forests are significant for reducing CO2 emissions. The atmosphere has nearly 810 Pg C of carbon dioxide, and 1500 Pg C and 500 Pg C are contained in soil and terrestrial biomass, respectively, of which 60% is stored in forest systems (McKinley et al. 2011). Therefore, forests can store large amounts of carbon, and thus afforestation is a means to offset the emissions of greenhouse gases and reduce global warming. The Intergovernmental Panel on Climate Change reports that by 2030 up to 3.8 Pg C year can be mitigated through forest development. However, afforestation projects are

costly, it is estimated that US$70-160 billion per year is required for such projects (United Nations, 2015, p. 2). Therefore, financial incentives are required for the establishment of forests (Whitehead, 2011).

Nonetheless, forests establishment requires investment but forestry itself has considerable economic value. The forest sectors give back to the country's GDP in various ways. Firstly, over 50 million people around the globe have employment opportunities because of the forest sector and it contributes 0.9% to the global GDP (Food and Agriculture Organization of the United Nations, 2016). Secondly, forestry is beneficial for the pharmaceutical industry since forest plant extracts are required in three-quarters of all prescription drugs. Thirdly, the forest biodiversity caters to the global food economy. Fourthly, silvopastoral practices, and agroforestry are essential for sustaining the livelihood of approximately 300 million people who live in forests (Raina et al., 2011). Agroforestry improves crop yields and income levels of the local population, thereby reducing poverty in the area.

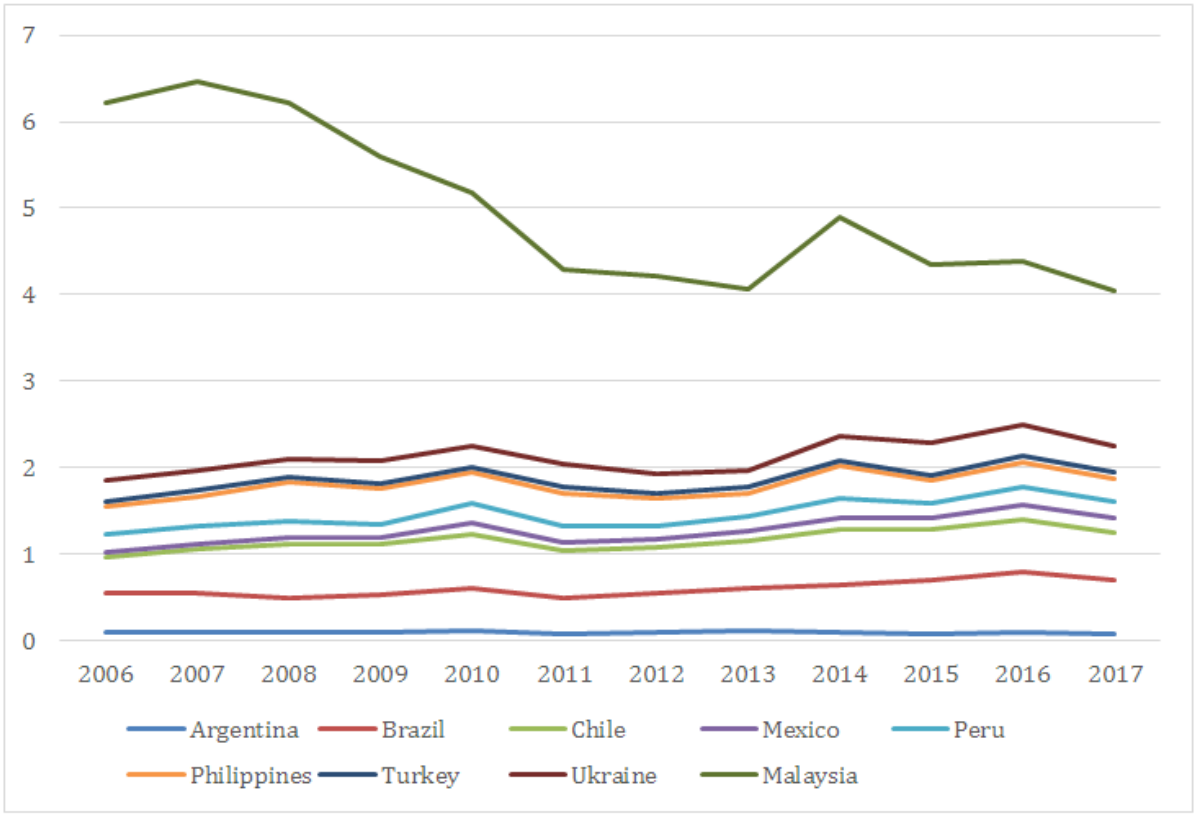
However, if we look at the forest rents of our sample countries, only Malaysia has a high percentage share of GDP, the remaining countries are far behind. Furthermore, from the graph, we can see that even Malaysia is not sustaining this percentage but rather there is a declining trend. This depicts that these countries have not used the forest sector to its full potential.

Table 5: Forest Rent (2017) as % of GDP

Argentina	Brazil	Chile	Mexico	Peru	Philippines	Turkey	Ukraine	Malaysia
0.082	0.615	0.558	0.160	0.187	0.277	0.062	0.300	1.812

Source: World Bank Indicators

Figure 2. Forest Rent as % of GDP



Source: World Bank Indicators

Overall, the results show that, on one hand, manufacturing value-added, energy production, and urban population are responsible for the surge of this emission in the atmosphere while on the other hand, forest and trade openness are significantly reducing the amount of carbon dioxide emissions in the atmosphere. Hence, focusing on increasing forest cover by planting trees and by protecting existing forests can be used as a strategy to mitigate environmental degradation caused by pro-growth policies. These outcomes confirm the effectiveness of our proposed strategy to focus on increasing forest cover along with pursuing growth led policies to achieve economic prosperity.

Results of Diagnostic Tests

To confirm the validity of GMM estimates, we need to check for over-identifying restrictions for the validity of instruments and make sure that the endogeneity issue does not exist, check for the absence of serial correlation, and check for the overall fitness of goodness of the model. Sargan Test and AR (2) tests are used to confirm the reliability of instruments and the absence of serial correlation respectively. In addition, F-Stats or Wald Chi-Square tests is

used to determine the fitness of the model. The output of these tests is given in Table 2 below.

Table 6: Results of Diagnostic Tests

Tests	**Sargan Test**	**AR(2) Test**	**F-Stats/ Wald ChI-Sq**
Output	0.1718	.081	4412.50

Output is the p-values of the Sargan test, used for confirming the validity of the instruments and AR(2) test which is used to check second-order serial correlation and test statistic of F-test/Wald Chi-Square test which is used for overall fitness of goodness.

The insignificant p-value of the Sargan test makes us unable to reject the null hypothesis of the validity of over-identifying restrictions. This confirms that there is no endogeneity issue and the instruments used are valid. AR (2) test is used to check for autocorrelation of order 2. We are unable to reject the null hypothesis of the absence of second-order serial correlation at 5% level of significance. Hence, the output confirms that there is no autocorrelation issue. Lastly, the high value of F-statistic confirms the overall fitness of goodness of the model. Hence, diagnostic tests confirm that the results given in Table 1 are free from any statistical estimation issue.

Robustness and Validity Check

To check the robustness of the above results, the current study used static econometric models such as fixed effect model (FE), random effect model (RE), and partial corrected standard error model (PCSE) with Panel specific AR (1). The estimation output is given in Table 3. The output confirms that the results reported in Table 4 are robust.

Table 7: Robustness Check

Regressors	**FE**	**RE**	**PCSE**
CO_2	N/A	N/A	N/A
FA	-.248 [.1473]	-.211 [.1252]	-.006*** [.0013]
MFVA	.147*** [.0395]	.145*** [.0389]	0.309*** [.0685]
UP	1.036*** [.0760]	1.037*** [.0741]	.698*** [.0977]
EPC	.012*** [0.0009]	.013*** [.0009]	.008*** [0.0009]
TRADE	-.001*** [0.0004]	-.001** [.0004]	.003*** [0.0009]
CONST.	-7.205***	-7.66***	-8.356***

	[2.1400]	[1.7632]	[0.4916]
F-Stats/ Wald Chi Sq.	411.00	2097.34	1891.78
Hausman Test	0.9957	0.9957	N/A

S.E. values are given in square brackets. ***, ** and * are for significant values of coefficients at 1%, 5% and 10% level of significance. The sign of FA in all models show that this is economically significant. However, it is statistically significant in the PCSE model only.

Conclusion

Environmental improvement is necessary for our survival and economic growth is necessary for poverty reduction and better standards of living. Therefore, neither can be compromised and this poses a dilemma of how to achieve sustainable economic growth. The paper explores this question by applying the system GMM estimation methodology for the period of 1991 to 2015 on nine emerging countries that are also in the top 120 environmentally affected countries. The countries under study are namely, Argentina, Brazil, Chile, Mexico, Peru, Philippines, Turkey, Ukraine, and Malaysia.

The current study collected the annual data on carbon dioxide emissions, forest area, manufacturing value-added, urban population, electricity production from coal and oil as a percentage of total electricity production, and trade openness as the sum of imports and export. Furthermore, the validity of GMM estimates was confirmed by applying the Sargen Test, AR(2) test, and F-Stats or Wald Chi-Square test. Lastly, robustness was confirmed by using static econometric models such as fixed effect model (FE), random effect model (RE), and partial corrected standard error model (PCSE) with Panel specific AR (1).

According to results, industrialization, energy production, and urban population have a statistically significant and positive impact on carbon dioxide emissions. Whereas, trade openness and forest area have a statistically significant and negative impact on carbon dioxide emissions. Therefore, the results are consistent with the claim of the current study that growth leading policies are responsible for environmental degradation and one should focus on such policies that have a dual positive impact. In emerging and especially developing countries the need to reduce poverty through employment takes primary importance. Therefore, recommending these countries to cut down production is not feasible. Instead, the policies should provide growth and improve the environment simultaneously. Therefore, forest area and trade openness, both are growth leading factors and should be considered to be a good remedy for environmental degradation.

Moreover, since the problem is global, Watson et al., (1998) proposes that though difficult to attain, the solution should come through a coordinated global control. For example, under the

Kyoto Protocal (1997), individual countries were encouraged to improve their carbon uptake and storage in forest biomass. Following it, the USA has offset its fossil fuel emissions by 12-19% via forests and forest products. Therefore, more initiatives like this should be taken and its implementation should be continuously monitored.

Moreover, pollution from industrialization should be mitigated through the use of pollution permits and severe penalties. Additionally, the problem of urbanization can be tackled through better developmental planning with a focus on eco-friendly systems. A lot of countries have started making efforts, for example, the US has decided to build eco-cities where 50% of the power will be generated from renewable sources of energy and it will have its own local organic farm for which the fertilizer will be made through waste. Likewise, China has plans to build a vertical forest in Jiangsu province which will have 3000 plants. The two towers of plants will absorb 25 tons of carbon dioxide and will produce 60 kg of oxygen each day while also being home to offices, schools, museums and a club. Lastly, dependence on non-renewable energy sources should be reduced and the utilization of renewable energy sources such as solar and wind increased.

Furthermore, this study has its limitations. There could be more potential determinants of CO2 emissions. Future research may be conducted by investigating the relationship between renewable energy consumption, intra-industry trade, foreign direct investment, and interest rate. Also, carbon emission is only one of many indicators of environmental impacts, thus, future research should study other variables such as GHG emission. Furthermore, the study used a limited number of countries, future research may explore the problem with a larger sample or with different countries.

Lastly, the UN defines sustainable forest management as “a dynamic and evolving concept, [which] is intended to maintain and enhance the economic, social and environmental value of all types of forests, for the benefit of present and future generations” (United Nations General Assembly, 2008, p. 2). Therefore, more research in the area is warranted because past literature has clearly diagnosed the problem but there is relatively less literature that explores the treatment and provides solutions.

Declarations
Funding Authors received no funding from any source for this research.
Conflicts of interest/Competing interests Authors declare no conflict of interest.
Availability of data and material Data sources are disclosed.
Code availability Program codes for data analysis are available on demand.

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