PLOS ONE

RESEARCH ARTICLE

Social and economic factors responsible for environmental performance: A global analysis

Chong Wang[1], Peter W. Cardon[2], Jing Liu[3], Ghulam Rasool Madni[4]*

1 Department of Management, School of Economics and Management, Northeast Electric Power University, Jilin City, China, **2** Department of Communication, Marshall School of Business, University of Southern California, Los Angeles, CA, United States of America, **3** Technology Economic Department, School of Management, Jilin University, Changchun, China, **4** Department of Economics, The University of Lahore, Lahore, Pakistan

* ghulam.rasool@econ.uol.edu.pk

Abstract

Several factors influence the environmental performance simultaneously but ethnic fractionalization, political freedom, financial development and institutional quality have a substantial impact to explain the environmental performance across economies. This study focuses to explore that how environmental performance is affected by these economic, political and social indicators by using the annual data of 163 developed and developing countries covering the time period of 1996-2016.The data is collected from World Development Indicators, World Governance Indicators, Freedom House and Cline Centre. The stationarity of variables is analyzed through LLC, IPS and ADF Fisher Chi-square test. Before applying panel ARDL approach to find out the long run relationship among variables, order of integration is determined through Pedroni's cointegration test. The findings of study highlight that ethnic diversity; institutional quality and political freedom play a significant role to decrease CO_2 emissions while energy consumption, GDP growth and financial development are increasing the environmental degradation. Ethnic diversity is a source of creative and innovative approaches about problem solving of environmental degradation. Political freedom allows people to participate in decision making that posits much compliance with environmental agreements. The foreign direct investment is attracted by good quality institutions which cause to advent of more environment friendly technology along with attractions for further innovations that may helpful to reduce CO_2 emissions. Contrary, GDP growth, financial development and energy consumption enhance the industrialization and urbanization leading to increase the level of CO_2 emissions. It is suggested for policy makers that cohesion among different ethnic groups; improving institutional quality; providing political freedom to people and inclusive financial sector will acknowledge the less pollutant environment.

Introduction

We are sure that climate change is occurring, that will worsen if we do not act quickly to stop it. If measures are not taken, it is estimated that emissions of carbon dioxide (CO_2) will be

almost doubled or tripled by 2050 [1]. According to the study [1], CO_2 emissions are main contributor to climatic changes and responsible for gradual increase in global temperature. The global emissions of CO_2 have increased from two billions tones of CO_2 in 1900 to over 36 billion tones in 2015. The growth of CO_2 emissions are further increased by 2.7% and 0.6% in 2018 and 2019 respectively. The global average CO_2 emissions were 4.8 tonnes per person in 2017. Due to increased CO_2 emissions in the atmosphere, global temperature is rising sharply. In the period of 1961–1990, temperature raised to 0.7 centigrade while temperature was 4 centigrade colder in 1850.

To control the environmental degradation and determining the channels of such deterioration is a big challenge now days for researchers and policy makers. According to the study [2], three research strands determine the relation between environmental pollutants and other factors in literature. The first strand explores the nexus of growth and environmental pollutants, testing through Environmental Kuznets Curve (EKC). The second strand discusses the relationship between energy consumption and economic output while the third strand is a combination of above two strands investigating the dynamic behavior among environment, economic growth and social factors [3–4]. The third strand, finding the relationship between socio economic determinants and environmental degradation has wide implications for evaluation and formulation of policy design to improve the environmental quality while the social factors responsible for environmental performance are required to be further explored.

One of broadly familiar policy recommendations for economic prosperity and growth are institutions. The importance of institutions for environmental performance is highlighted by [5] arguing that weak institutional quality is associated with bad governance, poor enforcement of contracts, less secure property rights leading to poor environmental policies to reduce Carbon Dioxide emissions. Effective policies and regulations have tendency to compensate the undesired effects of climatic changes and reduce the CO_2 emissions. The weak institutions and poor governance are unable to implement the environmental policies effectively. Institutional quality is a magic option for environmental problems [6] while [4] described that the effects to enhance the growth may be improved further when harmonizing policies like institutional quality, absence of corruption, bureaucratic quality, prevailing law and order and accountability of bureaucrats are accompanied, therefore, institutional reforms can benefit both environmental and macroeconomic variables in Africa. There is positive relationship between environmental quality and institutions [7–9]. It is believed that when people have freedom of information and political rights, it will increase the awareness about environmental interests which encourage the environmental legislation. The study [9] determined the significance of institutional quality for environmental performance. The powerful and sound institutions improve the environmental degradation through relocation of dirty industries and providing guidance against the pollution. While the poor and weak quality institutions for environmental management put lot of challenges towards pollutants. The findings of [10] reveal that one percent increase in quality of institutions is able to reduce CO_2 emissions by 0.313% for a panel of 47 economies using dynamic panel GMM estimation technique. The outcome of [11] highlights that one unit increase in institutional quality leads to decrease Carbon Dioxide emissions by 0.483% for a sample of 93 countries over the period of 1995–2014.

Another social aspect for environmental performance is ethnic fractionalization. Increased migration and globalization has highlighted an important relationship between ethnic fractionalization and environmental policies. The growing interest to perceive the applications of ethnic diversity generated substantial literature on the topic but relationship between environmental performance and ethnic diversity is still at its infancy. There are several reasons establishing the relationship between environmental performance and ethnic diversity. A more diverse society has greater level of innovations and devise technology that reduce

environmental degradation [12]. According to the findings of [13], students exposed to ethnic diversity, racial and cultural have tendency to be active participation in civic organizations and community services, compared with students having limited interaction with heterogeneous groups. It is argued that heterogeneous groups have tendency to adopt better decision making and environmental performance.

The role of politics for environmental performance cannot be negated and one of the core reasons for environmental problems [14–16]. Capitalist economies form a "treadmill of production" creating the ecological problems through an embedded self operating procedure of ever more consumption and production. The logic of the "treadmill of production" is a growing requirement for capital investments to produce commodities for sale in the markets. Corporations have intention for maximization of return on capital investments so they make continuous efforts to decrease cost of production through improved technology. This technology is a source to improve the efficiency in one area leading to environmental improvement. The reinvestment of profits to increase the production also increases the environmental performance as well as economic growth. The economic expansion makes two logical dynamics of an economy: the creation of economic wealth and secondly, the creation of the negative byproducts of production process. So [16] argued, "Thus the treadmill operates to maintain a positive rate of return on investments and externalizes the environmental costs of its activities. The social and economic benefits of the treadmill are unevenly distributed in favor of business and affluent communities, whereas the environmental risks associated with the treadmill are disproportionately concentrated among specific groups of people with the least ability to resist the location of polluting facilities in their community. Thus polluting facilities are sited among the most vulnerable groups: the poor, unskilled laborers and the skilled blue collar residents". The theory of treadmill insights the many actors of the economy those control the process of production in developing as well as developed countries deteriorating the environment. With rapid expansion of industrialization, the resultant pollution has deteriorated the environment [16–19].

The importance of financial sector for environmental performance cannot be negated. Development of financial sector has gained momentous importance due to its importance for economic and technological innovations. Financial development is responsible to channelize the savings of the economy and offer the economic agents to keep assets in liquid forms and encourage investment. The advancements in financial and technological sectors are resulting significant impacts on environmental performance. The studies [20–21] acknowledged the crucial importance of financial sector when evaluating the environmental performance of any economy. Financial sector could have an impact on environmental performance through different channels. It provides the necessary capital to industries and firms causing to increase the environmental pollutants. According to [22–24], financial development is responsible for environmental degradation in context of economic growth due to industrial expansion and pollution. When financial system is efficient, then there is convenience for producers to get loans as well as for consumers buying those products emitting CO_2 like air conditioners, generators, vehicles and construction of houses. Contrary, environmental friendly technology facilitated through financial mediators will decrease the environmental degradation at less financial cost. The expansion of green industry is establishing a negative relationship between financial development and environmental deterioration [21, 25].

There exists an extensive literature exploring the relationship between environmental pollutants and economic growth but the relationship of ethnic fractionalization, institutional quality and financial development is needed to be explored further. The objective of this study is to jointly link the relationship among environmental performance, ethnic diversity, institutional quality, political freedom and financial development across the developing as well as

developed countries. More concisely, this study determines the socio-economic factors of environmental degradation.

Data, model and methodology

This section comprises on the details of data, empirical model and estimation technique. The primary objective of this study is to establish the link between environmental performance, ethnic fractionalization, institutional quality, political freedom and financial development. Therefore, following simple model is specified to determine the empirical relationship:

$$\mathbf{CO_2 = f(EC, ED, FD, IQ, PF, YP)}$$

where CO_2 is carbon dioxide emissions; EC is energy consumption, ED is ethnic diversity, FD is financial development, IQ is institutional quality, PF is political freedom, and YP is real GDP per capita.

Environmental preserving is a big challenge facing humanity officially warned by United Nations. There are many factors responsible for environmental deterioration like solid waste, soil erosion, deforestation, water pollution and CO_2 emission. However, there is limited availability of data for other variables. So this study considered CO_2 emissions as a proxy of environmental degradation because carbon emissions are a major pollutant and responsible for about 75% of GHG (Greenhouse Gas) emissions [26]. Carbon Dioxide emissions are also most applied emission in EKC (Environmental Kuznets Curve) application [27]. The Table 1 describes the variables, their measurement and sources.

Annual data is collected from World Development Indicators (WDI), World Governance Indicators, Cline Centre and Freedom House over the period of 1996–2016 for 163 countries of world. The data is freely available to everyone and can be accessed at web sites of source organizations. An index by Principal Component Analysis (PCA) is developed to measure the institutional quality through six indicators measured by World Governance Indicators; voice and accountability, political stability and absence of violence, government effectiveness, regulatory quality, rule of law and control of corruption. "The WGI are composite governance indicators based on over 30 underlying data sources. These data sources are rescaled and combined to create the six aggregate indicators using a statistical methodology known as an unobserved components model. A key feature of the methodology is that it generates margins of error for each governance estimate. These margins of error need to be taken into account when making comparisons across countries and over time. The six aggregate indicators are reported in two ways: (1) in their standard normal units, ranging from approximately -2.5 to 2.5, and (2) in percentile rank terms from 0 to 100, with higher values corresponding to better

Table 1. Description of variables.

Variable	Elaboration	Source
Carbon Dioxide Emission	Per Capita Metric Ton	WDI
Energy Consumption	Kilograms of oil equivalent of energy use per capita	WDI
Ethnic Diversity	Index is constructed	Cline Centre
Financial Development	Stock Market Capitalization as % of GDP	WDI
Institutional Quality	Index is constructed	WGI
Political Freedom	Index	Freedom House
GDP	Per Capita GDP	WDI

Source: Author's compilation

outcomes." The details of WGI aggregate indicators and underlying source data are available at www.govindicators.org. The CO_2 is measured in metric tons per capita and considered as dependent variable. To measure the financial development, stock market capitalization is used as an independent variable which is share of all domestic listed companies as percentage growth of GDP while energy consumption measured by kilograms (kg) of oil equivalent of energy use per capita. The data of ethnic diversity has been obtained from the database of Cline Centre for Democracy, University of Illinois. It is important to mention here that ethnic diversity data has also been collected for the same countries for which the rest of data has been taken. The data of countries included in this study taken from the Cline Centre's and Societal Infrastructures and Development (SID) Project. For measurement of diversity (ethnic and religious), this study follows the exact same technique as used [28] by using the following fractional formula;

$$\mathbf{FRACT_K = 1 - \sum_{i=1}^{N} D_{Kj}^2}$$

Here, $\mathbf{D_{Kj}}$ represents, how much a group share (i) such as K = 1. . . . . .N and generally fractionalization index yield result between zeros to one. If this is zero (0) it means homogenous country (totally not diversified country) and one (1) shows absolutely heterogeneous country.

The political freedom variable is a proxy for political freedom index obtained from the Freedom House. This index measures whether a government came to power by election or by gun, whether elections, if any, are free and fair, and whether an opposition exists and has the opportunity to take power at the consent of the electorate. The value of index varies from 1 to 7 where value from 1.0 to 2.5 shows political freedom, 3.0 to 5.0 is partial political freedom while 5.5 to 7.0 represents no political freedom in a country. Depending on the values of index, countries are classified as "Free", "Part(ial)ly Free" or "Not Free".

Per capita GDP has a significant impact on Carbon Dioxide emissions for any economy. This study used real per capita GDP to capture its affects for environmental degradation. The main difference between nominal and real GDP is the adjustment for inflation of the country. Real GDP is output and income of any country accounts for deviations in prices and hence sketches a truer picture of economic growth. The data of real per capita GDP is collected from WDI.

Results and discussion

To understand the relationship between CO_2 emissions and other socio economic factors, a number of analytical tools are applied, comprising the stationarity tests and panel ARDL technique. The economic policies showing their effects on micro and macro levels require a delay of specific time period. So this study used the panel ARDL approach to analyze the impact of lagged values. When level of stationarity of variables is different, the analysis becomes more complicated. The order of integration is needed before applying co integration technique. Levin, Lin & Chi (LLC), Im, Pesaran and Shin (IPS) and ADF Fisher Chi-Square tests are applied to find the order of integration. The reasons behind selection of these panel unit root tests are their large potential of power gains and better handling of even small data sets along with additional advantage of simplicity. The LLC unit root test also allows heterogeneity in constant term while IPS test is the average of ADF statistics having ability to handle heterogeneity both in trend and constant. Table 2 shows the findings of panel unit root tests.

The reported results indicate that some of the variables are integrated at level while some are integrated at first difference. Therefore, we are able to apply panel ARDL bounds testing

Table 2. Panel unit root tests (individual intercept).

Variable	IPS		LLC	
	Level	1st Difference	Level	1st Difference
CO_2 Emission	-0.44(0.35)	-22.41(0.00)	-1.54(0.07)	-5.57(0.00)
Ethnic Diversity	-2.81(0.02)	-4.47(0.00)	-1.84(0.06)	-3.84(0.00)
Energy Consumption (EC)	2.74(0.88)	-20.47(0.00)	-0.46(0.54)	-19.81(0.00)
Institutional Quality (IQ)	-3.98(0.00)	-2.77(0.00)	-1.36(0.00)	-3.33(0.00)
Financial Development (FD)	1.68 (0.87)	2.89 (0.00)	-0.61 (0.24)	-2.95(0.00)
Political Freedom (PF)	-0.42 (0.34)	-24.44(0.00)	-1.38(0.08)	-22.59(0.00)
Per Capita Real GDP (YP)	5.77(1.00)	-12.58(0.00)	-2.81(0.75)	-12.21(0.00)
Individual Intercept and Trend				
	Level	1st Difference	Level	1st Difference
CO_2 Emission	-4.71 (0.00)	-20.23(0.00)	-5.57(0.00)	-18.42(0.00)
Ethnic Diversity	-5.77(0.07)	-8.77(0.00)	-3.76(0.06)	-20.94(0.00)
Energy Consumption (EC)	1.65(0.92)	-19.57(0.00)	-0.67(0.23)	-17.38(0.00)
Institutional Quality (IQ)	-4.56(0.00)	-20.77(0.00)	-0.36(0.00)	-15.33(0.00)
Financial Development (FD)	-3.11(0.56)	5.11 (0.00)	-4.78(0.10)	-13.45(0.00)
Political Freedom (PF)	-4.35(0.00)	-21.13(0.00)	-6.64(0.00)	-18.59(0.00)
Per Capita Real GDP (YP)	3.55 (0.98)	-12.88(0.00)	0.69(0.69)	-8.64(0.00)

The values in brackets represent p-values.

approach to determine the long run relationship between socioeconomic determinants of environmental degradation. The panel ARDL approach allows using the lagged values of dependent variable as an independent variable. These types of models can be accommodated for general lags structures and flexible to provide short and long run empirical outcomes. The panel ARDL models are also good remedy for spurious regressions and resolve the biasedness due to heterogeneous slope. It allows all coefficients of the model to vary in long and short run. The ARDL models are more efficient to capture the relationship among variables in spite of small data samples.

The Pedroni's co integration test is a popular test to determine the conintegration among the variables due to considering the heterogeneity and specific parameters are allowed to vary across individual members of the sample. This test proposed seven different statistics to know the co integration in panel data. The first four are based on pooling known as within dimension while later three are between dimensions. All statistics focus on the null hypothesis of no co integration. The estimated results are reported in the following Table 3.

The estimated results reveal that four statistics from seven, reject the null hypothesis of no co integration. Moreover, panel ADF and group ADF statistics are considered more reliable

Table 3. Pedroni's cointegration test.

	Statistics	Probabilities
Panel v-statistics	-0.037968	0.5151
Panel rho-statistics	-0.081484	0.4675
Panel PP-statistics	-2.730752	0.0032
Panel ADF statistics	-2.913230	0.0018
Group rho-statistics	0.610338	0.7292
Group PP-statistics	-3.445830	0.0003
Group ADF statistics	-3.376291	0.0004

Table 4. Pooled mean group long run estimates.

Variable	Coefficient	Std. Error	Prob.
Ethnic Diversity (ED)	-0.207	0.088	0.019
Energy Consumption (EC)	0.134	0.036	0.010
Institutional Quality (IQ)	-0.464	0.056	0.000
Political Freedom (PF)	-0.649	0.077	0.061
Per Capita Real GDP (YP)	0.085	0.053	0.072
Financial Development (FD)	0.107	0.053	0.047
Constant	0.133	0.0316	0.000

https://doi.org/10.1371/journal.pone.0237597.t004

[29]. Therefore, it can be concluded that there exists long run relationship among variables for our panel data. After finding the presence of long run relationship among variables, the findings of Hausman test (Prob Chi^2 = 0.9992) show that pooled mean group estimation of ARDL is more suitable for empirical analysis.

The above reported Table 4 and Table 5 reveal the long and short run relationship of variables affecting the environmental performance for a sample of 163 developed and developing countries. The empirical estimation highlights that ethnic fractionalization has a significant negative impact on CO_2 emissions in the long and short run. The findings of the study are also consistent with findings of studies [13, 30–32]. The ethnic diversity in a country encourage the participation and support to community activities like environmental action programs so its benefits emerge at country level and facilitate to achieve environmental targets. According to the findings of [13] that ethnically diverse societies have more tendency to be "more active participants in community service and civic organizations, compared to those who have more limited interaction with heterogeneous groups. So diversity improves an organization's flexibility and aids in attracting high-quality human talent."The studies [32–33] are of view that ethnic diversity is a source of creative and innovative approaches about problem solving and adding value to an economy. The generated ideas for problem solving in a heterogenous society are of better quality as compared with society comprising homogenous groups. Now it is well perceived that environment is a public good and cannot be restricted for any one so a collective action is required as environmental quality cannot be improved in isolation. To meet such challenges, it requires the creative and innovative human capital to develop the techniques and methods to improve the environmental quality.

As regards to the energy consumption variable, it is observed that higher energy consumption leads to an increase in CO_2 emissions in short run as well as in long run. Such an evidence is in agreement with the related literature [34–35]. The studies [7, 36] found that energy consumption is responsible to increase environmental degradation in MENA countries. The positive relationship between carbon dioxide emissions and energy consumption is also found

Table 5. Pooled mean group short run estimates.

Variable	Coefficient	Std. Error	Prob.
Ethnic Diversity (ED)	-0.018	0.025	0.045
Energy Consumption (EC)	0.199	0.032	0.001
Institutional Quality (IQ)	-0.143	0.098	0.149
Political Freedom (PF)	-0.214	1.995	0.914
Per Capita Real GDP (YP)	0.088	0.063	0.159
Financial Development (FD)	0.327	0.057	0.031
ECT(-1)	-0.293	0.084	0.007
Constant	0.116	0.176	0.510

https://doi.org/10.1371/journal.pone.0237597.t005

positive for European countries by testing different estimation techniques like dynamic ordinary least square, fully modified ordinary least square and ordinary least squares [37]. The One Belt One Road (OBOR) economies are also analyzed for relationship between CO_2 emissions and energy consumption and a positive relationship is observed for these economies [38]. All above studies and findings of this study reveal that energy consumption significantly increases the CO_2 emissions in the atmosphere.

Regarding the impact of institutional quality on environmental performance, it is evident from estimated results that high quality institutions play a significant role to reduce environmental performance. The possible reason is foreign direct investment, attracted by the good institutional quality which causes the advent of more environmental friendly technology in a country that may helpful to reduce CO_2 emissions. Moreover weak institutional quality fails to impose better environmental policies which cause the deterioration of the environment. The studies [39–40] theorized the role of institutional quality for environmental protection. The framework of institutions of any economy influences the way economic activities may impact the environmental performance. The improvement of institutional quality promotes the innovations and environmental friendly approaches for production and consumption processes. Moreover, competition in developing and developed countries is a source of higher productivity and efficiency resulting to lower the level of CO_2 emissions. It is concluded that institutions matter for economic prosperity and impact of economic growth on carbon dioxide emissions is conditional on institutional quality [11, 41–42].

The impact of political freedom on CO_2 emissions is negative in both specifications, suggesting that high level of political freedom is also a source to reduce CO_2 emissions in long run. The earlier research also supports the relationship between democracy, civil and political freedom, and environmental performance and protection but the findings are inconclusive. The studies [43–44] highlighted that democracy is a better tool to safeguard the environment of a country due to dissemination of environmental information result of free gathering and interaction. Democracy is associated with stable and clear property rights providing incentives for protection of natural resources [45]. The studies [46–47] theorize that democratic states are much responsive to the environmental performance as compared with autocratic states. The supremacy and respect for rule of law in democracies posits much compliance with environmental agreements. Additionally, there is positive and significant relationship between democratic accountability and national environmental performance [48].

The estimated results show that GDP per capita has a positive and significant impact on CO_2 emissions in long run while insignificant in short run. The reason is that economic growth usually changes the style of the production process, industrialization, and urbanization. The positive relationship between economic growth and CO_2 emission is supported by the studies [20, 35, 49]. The relationship between economic growth and environmental degradation was fuelled by Environmental Kuznets Curve and later on it was explored massively and different shapes of EKC were discovered; U-shaped, inverted U-shaped, inverted N-shaped, N-shaped, M-shaped and linear. The studies elaborate that economic growth increases carbon dioxide emissions up to a certain point then further growth declines the emissions level and further economic growth will raise the level of CO_2 emissions again [50–52].

According to the findings of this study, financial sector is contributing significantly to deteriorate the environment. The study [53] is of view "financial sector is today recognized as an important link ensuring the proper working of an economy given its importance in acquiring of reserves, as well as easing of business deals and supervising of resources toward effective sectors. In addition, the flourishing of the financial sector, led by technological innovations, has significantly contributed to economic growth and the development of economies hosting such financial services generally." However, the role of financial sector to enhance economic

development is not deniable, but it is posing impact on the environmental performance also which has been a major cause of concern for countries, striving to mitigate the negative impact of CO_2 emissions. However, the effect of financial development on CO_2emissions is found to be significant and our finding is in consonance with the studies [21, 52, 54].

Conclusions

Economic development and environmental preservation are two main challenges of humanity now days. However, environmental protection is emerged at forefront of recent issues for developing and developed countries due to climatic changes and global warming. It is imperative to understand for leaders and policy makers that why environmental targets are achieved by some countries and others fail. So this paper is an effort to investigate the relationship between Carbon Dioxide emissions ant its potential social, political and economic determinants like ethnic diversity, institutional quality, political freedom, energy consumption, financial development and economic growth for a panel of 163 countries covering the period of 1996–2016. A panel ARDL approach is applied to determine the long and short run analysis while LLC, IPS and Fischer Chi square test are applied to test the stationarity of the variables.

The estimated results highlight that ethnic diversity; political freedom and institutional quality have their significant role to decrease the CO_2 emissions while energy consumption; economic growth and financial development have positive and significant impact to deteriorate the environment. The ethnic diversity may encourage the cooperation and cohesion of people to take care of their environment. The increased awareness and knowledge embedded in ethnic fractionalization will be a source to overcome the environmental deterioration. Ethnic diversity in a country tends to be productive, innovative and creative for problem solution so it is an advantage to obtain environmental targets though social and civic cohesion. The moderate level of ethnic fractionalization has prime importance to achieve the environmental challenges. During the last two decades, specific environmental institutions and organizations are built to meet the challenges they face. The decrease in CO_2 emissions with increasing GDP is explained by the greater effectiveness of institutional quality. The high quality institutions attract the foreign investors in an economy due to low volume of transactions costs that result the advancement of environment friendly technology. Producers (multinational) know the green house effect and use energy-saving technologies to reduce carbon dioxide emissions. Resultantly, consumers have a great benefit from this technological change. Due to political freedom, people are able to be part of decision making process and able to design those policies which are beneficial for their own and next generations while autocratic governments have less intention for consideration of environmental policies. The World Systems Theory (WST) has extended the debate of global economic system in context of political economy and environmental protection. The treadmill of production is a source of technological progress associated with environmental degradation also. The environmental deterioration will continuously increase with expansion of economies. The advent of new technologies will not decrease the extent of environmental deterioration but the solution rests upon political restructuring of economies towards environmental sustainability and away from the race of economic growth. Financial development is also an indirect source of economic growth and increase in economic growth is a source of rapid industrialization and energy consumption. It is responsibility of government to slow down the process of industrialization with special focus to those industries which are emitting high level of carbon dioxide in the atmosphere. The use of environmental friendly machinery may be policy tool for industry.

The active role of government is necessary to protect the environment. Mere economic aspects are not sufficient to stop environmental deterioration but social indicators are also

needed to be focused with special reference to institutional quality, political freedom and eth- nic diversity. If institutional quality is better then people have trust on law enforcement authorities and any restriction to protect the environment will be accepted by the public, oth- erwise people will not abide by environmental laws when people have chance to escape. The political system can be structured in such a way by including the people in decision making. If people actively participate in decision making then responsibility to act upon those decisions will be endorsed massively. Besides, most of countries have ethnic fractionalization and it is a source of innovation and creativity so an atmosphere of social cohesion and being respected may have positive consequences for environmental protection. In addition, energy efficient and environmental friendly technologies may be adopted to stop environmental deterioration. It will increase productivity on the one side and will decrease the CO_2 emission on the other side. All above discussion can be concluded that participation of people in decision making through political freedom in an efficient institutional environment along with ethnic fraction- alization will preserve the environment for the long time. The negative impacts of economic expansion and financial development on environment may be reduced through use of green technologies, a policy direction for the policy makers.

The study presents some findings based on empirical analysis but exceptions are there. In particular, countries are heterogeneous with respect to their social, political and economic conditions. So it might be a topic for future research. Moreover, institutional quality and eth- nic diversity can be measured with more indicators to have more rigorous analysis.

Supporting information

S1 Appendix. List of countries.
(DOCX)

Author Contributions

Conceptualization: Ghulam Rasool Madni.

Formal analysis: Chong Wang.

Funding acquisition: Chong Wang.

Methodology: Peter W. Cardon.

Writing – review & editing: Jing Liu.

References

1. Ritchie H, Roser M. CO_2 and Greenhouse Gas Emissions. 2017. Published online at OurWorldInData. org. Retrieved from: https://ourworldindata.org/co2-and-other-greenhouse-gas-emissions

2. Hale M T, Selden T M. Panel Stationarity with Structural Breaks: Carbon Emissions and GDP. Applied Economics Letters.1999; 6 (4):223–225.

3. Acaravci A, Ozturk I. On the Relationship between Energy Consumption, CO_2 Emissions and Economic Growth in Europe. Energy Policy. 2010; 35 (12):5412–5420.

4. Zhang X P, Cheng X M. Energy Consumption, Carbon Emissions, and Economic Growth in China. Eco- logical Economics. 2009; 68 (10):2706–2712.

5. Alesina A, Zhuravskaya E. Segregation and the Quality of Government in a Cross Section of Countries. The American Economic Review. 2010; 101 (5):1872–1911.

6. Ibrahim M H, Law S H. Social capital and CO2 emission–output relations: A panel analysis. Renewable and Sustainable Energy Reviews. 2014; 29:528–534.

7. Sahli I, Rejeb J B. The Environmental Kuznets Curve and corruption in the MENA region. Procedia- Social and Behavioral Sciences. 2015; 195;1648–1657.

8. Ulman S R, Bujancă G V. The corruption influence on the macroeconomic environment. Empirical analysis on countries development stages. Procedia Economics and Finance. 2014; 16: 427–437.

9. Egbetokun A, Atta-Ankomah R, Jegede O, Lorenz E. Firm-level innovation in Africa: overcoming limits and constraints. Innovation and Development. 2016; 6(2):161–174.

10. Ali H S, Zeqiraj V, Lin W L, et al. Does Quality Institutions Promote Environmental Quality?. Environmental Science and Pollution Research. 2019; 26:10446–10456. https://doi.org/10.1007/s11356-019-04670-9 PMID: 30891699

11. Wawrzyniak D, Doryn W. Does the quality of institutions modify the economic growth-carbon dioxide emissions nexus? Evidence from a group of emerging and developing countries. Economic Research. 2020; 33(1):124–144.

12. Fafchamps M. Ethnicity and Credit in African Manufacturing. Journal of Development Economics. 2000; 61 (1):205–235.

13. Milem J. The educational benefits of diversity: Evidence from multiple sectors. In Chang M. J., Witt D., Jones J., & Hakuta K. (Eds.), Compelling interest. Stanford: Standard University Press. 2003; 130–159.

14. Schnaiberg A, Gould K. Environment and Society: The Enduring Conflict. New York: St. Martin; 1994.

15. Schnaiberg A. The Environment: From Surplus to Scarcity. New York: Oxford Univ. Press; 1980.

16. Gould K, Schnaiberg A, Weinberg A. Local Environmental Struggles: Citizen Activism in the Treadmill of Production. Cambridge Univ. Press, UK; 1996.

17. Mao K R, Jin S, Hu Y, Weeks N, Ye L. Environmental Conservation or the Treadmill of Law: A Case Study of the Post-2014 Husbandry Waste Regulations in China. International Journal of Offender Therapy and Comparative. 2020. Retrieved from https://journals.sagepub.com/doi/abs/10.1177/0306624X20928024?journalCode=ijoe

18. Curran D. The Treadmill of Production and the Political Economy of Consumption. Canadian Review of Sociology. 2017; 54(1): 28–47. https://doi.org/10.1111/cars.12137 PMID: 28220682

19. Islam S, Hossain I. The Global Treadmill of Production and the Environment. In: Social Justice in the Globalization of Production. International Political Economy Series. Palgrave Macmillan, London; 2015.

20. Shahbaz M, Hye Q M A, Tiwari A K, Leitão N C. Economic growth, energy consumption, financial development, international trade and CO2 emissions in Indonesia. Renewable Sustainable Energy Review. 2013; 25: 109–21.

21. Jalil A, Feridun M. The impact of growth, energy and financial development on the environment in China: A cointegration analysis. Energy Economics. 2011; 33:284–91.

22. Ayeche M B, Barhoumi M, Hammas M A. Causal linkage between economic growth, financial development, trade openness and CO2 emissions in European Countries. American Journal of Environmental Engineering. 2016; 6(4): 110–122.

23. Dhrifi A. Does Environmental Degradation, Institutional Quality, and Economic Development Matter for Health? Evidence from African Countries. Journal of the Knowledge Economy, 2018; 1–16. https://doi.org/10.1007/s13132-018-0525-1

24. Sehrawat M, Giri A K, Mohapatra G. The impact of financial development, economic growth and energy consumption on environmental degradation: Evidence from India. Management of Environmental Quality: An International Journal. 2015; 26(5); 666–682.

25. Yuxiang K, Chen Z. Financial development and environmental performance: Evidence from China. Environment and Development Economics. 2010; 16:93–111.

26. Abbasi F, Riaz K. CO$_2$ Emissions and Financial Development in an Emerging Economy: An Augmented VAR Approach. Energy Policy. 2016; 90: 102–114.

27. Tutlumaz O. Environmental Kuznets Curve Time Series Application for Turkey: Why Controversial Results Exist for Similar Models? Renewable and Sustainability Energy Reviews. 2015; 50: 73–81.

28. Alesina A, Easterly W, Kurlat S, Wacziarg R. Fractionalization. Journal of Economic Growth. 2003; 8: 155–194.

29. Pedroni P. Panel cointegration. Asymptotic and finite sample properties of pooled time series tests with an application to the PPP hypothesis. Econometric Theory. 2004; 20(3): 597–625.

30. Jayne M E A, Dipboye R L. Leveraging diversity to improve business performance: Research findings and recommendations for organizations. Human Resource Management. 2004; 43: 409–424.

31. Richard O C. Racial diversity, business strategy, and firm performance: A resource-based view. Academy of Management Journal. 2000; 43: 164–177.

32. Robinson G, Dechant K. Building a business case for diversity. The Academy of Management Executive. 1997; 11(3): 21–31.

33. McLeod P L, Lobel S A, Cox T H. Ethnic diversity and creativity in small groups. Small Group Research. 1996; 27: 246–264.

34. Tamazian A, Rao BB. Do economic, financial and institutional developments matter for environmental degradation? Evidence from transitional economies. Energy Economics. 2010; 32(1): 137–45.

35. Soytas U, Sari R. Energy consumption, economic growth, and carbon emissions: challenges faced by an EU candidate member. Ecological Economics. 2009; 68: 1667–1675.

36. Yazdi S K, Khanalizadeh B. Air pollution, economic growth and health care Expenditure. Econ. Res.-Ekon. Istraživanja. 2017; 30: 1181–1190.

37. Dritsaki C, Dritsaki M. Causal Relationship between Energy Consumption, Economic Growth and CO2 Emissions: A Dynamic Panel Data Approach. Int. J. Energy Econ. Policy. 2014; 4: 125–136.

38. Anwar A, Ahmad N, Madni G R. Industrialization, freight transport and environmental quality: evidence from belt and road initiative economies. Envi Sci & Poll Res. 2019; https://doi.org/10.1007/s11356-019-07255-8

39. Dasgupta S, Laplante B, Wang H, Wheeler D. Confronting the environmental Kuznets curve. Journal of Economic Perspectives. 2002; 16(1): 147–168.

40. Dasgupta S, Wheeler D, Mody A, Roy S. Environmental regulation and development: A cross-country empirical analysis. Oxford Development Studies. 2001; 29(2): 173–187.

41. Madni G R. Probing institutional quality through ethnic diversity, income inequality and public spending. Social Indicators Research. 2019; 142: 581–595.

42. Madni G R, Chaudhary M A. Economic growth in context of institutions and fiscal policy. Pakistan Economic and Social Review. 2017; 55(1): 79–98.

43. Payne R A. Freedom and the environment. Journal of Democracy. 1995; 6(3): 41–55.

44. Li Q, Reuveny R. Democracy and environmental degradation. International Studies Quarterly. 2006; 50: 935–956.

45. Dulal H B, Roberto F, Knowles S. Can differences in the quality of social institutions and social capital explain cross-country environmental performance? New Zealand Association of Economists Conference in Wellington. 9–11 July 2008.

46. Kotov V, Nikitina E. Russia and international environmental cooperation. In Bergesen H. O.& Parmann G. (Eds.), Green globe yearbook of international cooperation on environment and development. Oxford, UK: Oxford University Press; 1995.

47. Weiss E B, Jacobsen HK. Getting countries to comply with international agreements. Environment. 1999; 41: 16–23.

48. Grafton R Q, Knowles S. Social capital and national performance: A cross-country analysis. Journal of Environment and Development. 2004; 13: 336–370.

49. Moghadam H E, Lotfalipour M R. Impact of financial development on the environmental quality in Iran. Chinese Business Review. 2014; 13(9): 537–551.

50. Sinha A, Sen S. Atmospheric consequences of trade and human development: A case of BRIC countries. Atmospheric Pollution Research. 2016; 7(6): 980–989.

51. Shahbaz M, Dube S, Ozturk I, Jalil A. Testing the environmental Kuznets curve hypothesis in Portugal. International Journal of Energy Economics and Policy. 2015; 5(2): 475–481.

52. Ozturk I, Acaravci A. The long-run and causal analysis of energy, growth, openness and financial development on carbon emission in Turkey. Energy Economics. 2013; 36:262–67.

53. Zhuang J, Gunatilake H, Niimi Y, Khan M E, Jiang Y, Hasan R, Khor N. Financial sector development, economic growth and poverty reduction: A literature review, African Development Bank Working Paper Series, No. 173; 2009.

54. Islam F, Shahbaz M, Ahmed A U, Alam M. Financial development and energy consumption nexus in Malaysia: A multivariate time series analysis. Economic Modelling. 2013; 30: 435–441.