Environmental Regulations and Ecological Footprint trade-off within the Sustainable Development Corridor: Evidence from MINT Countries.

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Abstract

Income alone cannot ensure environmental sustainability. As such, different economies have relied on environmental regulations to preserve the quality of their environment. The efficiency of such regulations on environmental degradation is still unclear in developing countries culpable for lax environmental regulations. As such, this study explores the effect of environmental regulation on the ecological footprint (EFP) in MINT (Mexico, Indonesia, Nigeria, Turkey) countries from 1980-2016. The results suggest that energy consumption, trade and GDP increase the ecological footprint while environmental regulations reduce it thereby mitigating environmental degradation, though insignificantly. This indicates that environmental regulations are not totally successful in mitigating ecological distortions in the sample countries. The study applies the FMOLS estimator to obtain the country-wise results. There are evidences that energy consumption increases the EFP in all MINT countries. The same influence is exacted by trade on the EFP, except in Turkey. The abating role environmental regulations on environmental degradation was confirmed in all the countries. It was significant in Nigeria and Turkey, but no in Mexico and Indonesia. Further findings revealed a bidirectional causality between GDP and EFP. Policy directions are discussed within the framework of Sustainable Development Goals (SDGs).

Keywords: Environmental Regulations; Ecological Footprint; MINT; Panel Econometrics.

1. Introduction

For the past few decades, the attention of policy makers and researchers worldwide has been shifted from understanding of the nexus between environment quality and economic growth to how the nexus can be properly managed in such a way that ecological destruction and environmental degradation can be avoided. The growing concerns for the unprecedented environmental degradation can be best explained on the basis of the avalanche of carbon dioxide emission (CO2) that is being released to the atmosphere through the consumption of fossil energy by humans. There have been various reports on the increasing mortality rate related to environmental pollution related to energy consumption such as fossil fuels, coal, firewood, greenhouse gases (GHGs) and host of others (World Energy Outlook 2017). The world has also witnessed an avalanche reduction in the environmental quality, which is a consequent result of the increasing demand of economic growth through exploitation of natural resources by man. From another point of view, Environmental Kuznets Curve (EKC) was developed in a bid to explain how economic growth will continue to increase environmental degradation at the early stages of development until it reaches a maximum point where the nexus between growth and environmental quality becomes negative.

Akin to this, countries such as China (Guo, Qu, & Tseng, 2017; Hao, Deng, Lu, & Chen, 2018) and economic unions such as the European Union (Albulescu, Artene, Luminosu, & Tămășilă, 2019) have been made efforts to come up with measures to put the environmental pollution under control and technological advancement has been recognized as an effective way of reducing carbon emissions. However, there is a general consensus that carbon emissions are unwanted result of human exploitation of non-renewable energy such as firewood burning, fossil fuels etc. The inevitability of supplementary restrictions is becoming an issue of discussion in the literature and from which environmental regulations emerged. It is this regard the policy makers and researchers in economics and environmental studies realise that economic growth may not be sole way forward for improving environmental quality but also enacting stringent environmental regulations such as carbon tax, coal rent and host of others. Thus, environmental policies implemented by emerging economies will motivate polluting firms to massively invest in reducing environmental pollution and will pave way for transfer of technology to pollution-intensive countries where they are likely to enjoy comparative advantage in terms of their productivity (Z. Wang et al 2018).

This present study aligns its research focus on three major regions in the global economy, particularly the MINT (i.e. Mexico, Indonesia, Nigeria and Turkey) countries. MINT countries have shown progressive movement with some salient economic features such as increasing populations, which makes them to be unique with their potential prospects and they have been recognized widely as giant economies that play a key role in the global economy. Many studies in the literature have put MINT countries will contribute great quota to the world economy over the next few decades. Statistical report in 2016 shows that MINT countries had a net population of 654.1 million (Indonesia 261.1 million, Nigeria 186.0 million, Mexico 127.5 million, and Turkey 79.5 million) with likelihood of experiencing steady, rapid and sustainable growth over the next time horizons (https://data.worldbank.org/indicator/SP.POP. TOTL, accessed 24 September 2017). The economic objective of MINT countries is to find ways to fully industrialized economies but at the same time, energy consumption demand of the regions as a driver of their growth is posing serious threat to the environment and thereby making the cost of energy products and services to be unaffordable. To tackle the problem of environmental degradation in these countries, there have been series of environmental regulations and policies geared towards creating an environment with good qualities.

The empirical studies on the impact of environmental regulations and environmental quality have been recording contradictory results as the determinants of climatic change have become a topic of debate in the literature. The aim of this present study, therefore, is to examine the impact of environmental regulations on environmental qualities in MINT economies within the context of the popular Environmental Kuznets Curve (EKC) hypothesis. The different sections of the study is broken down as follows: the next section presents a review of literature on environmental regulation and environmental quality. Section three include the data, model and method, while section four discusses the results and implication for energy policy. Section five concludes the study with vital policy recommendations.

2. Literature Review

There are fairly large numbers of studies that have discussed environmental quality, emissions and the Environmental Kuznets hypothesis (EKC) in the literature (Alola, Bekun, & Sarkodie, 2019; Chen, Hao, Li, & Song, 2018; Cheng, Li, & Liu, 2017; Hashmi & Alam, 2019; Hassan, Danish, Khan, Xia, & Fatima, 2020; Jiang, Zhou, & Liu, 2019). Knowing too well the negative impacts of energy-led growth on environmental quality, governments are making efforts to enact policies that can be adopted to encourage consumption of clean energy sources. The question of the effectiveness of the regulations still remains a gap to be filled in the literature as the empirical studies on the effectiveness of environmental regulations are not consistent and commutative binding on divergent approaches to the individual study. Our study proposes to examine the relationship between environmental regulations and environmental quality for MINT economies, within the framework of Environmental Kuznets hypothesis (EKC) hypothesis. Since the scope of the study is MINT countries, the next subsections will focus on review of previous related studies which focus on environmental regulation and environmental quality nexus in MINT when compared with other regions.

2.1 Environmental regulation and environmental quality nexus in MINT countries

This section focuses on review of earlier studies in the literature on the nexus between environmental regulations and environmental quality in Mexico, Indonesia, Nigeria, and Turkey (MINT). There are fairly large numbers of studies that discuss the need for environmental regulations MINT economies based on their findings on energy cum growth-led climatic change. Shahbaz et al (2013) proposed energy efficient technologies as policy measure to control the environment from degrading after discovering that economic growth and energy consumption have negative impact on the environmental quality in Indonesia for the period from 1975 to 2011. Tajudeen (2015) considered the effects of energy efficiency policy and other factors that are not economically inclined on energy demand and CO2 emissions in Nigeria for the period interval between 1970 and 2012. The result shows that the existing policies from the supply side to reduce the carbon emissions are not sufficient and proposed the need for stricter environmental policies from the consumption side. Similarly, Sodri & Garniwa (2016) proposed regulatory policies in controlling the CO2 emissions in the megacity of Indonesia as the result of the study shows that urbanization policy overshoots the level of non-renewable energy consumption. Rafindadi (2016) also proposed massive investment in effective and sustainable renewable energy system after discovering a bidirectional causal relationship between economic growth and C02 emissions for time series data from 1971 to 2011 in Nigeria. Pata (2018) proposed coal and noncarbohydrate energy consumption as viable solutions to reduce environmental pollution in Turkey after finding an empirical evidence to support the claim within the context of Environmental Kuznets Curve (EKC) hypothesis

Furthermore, Uzar & Eyuboglu, (2019) also found a unidirectional causal relationship running from income inequality to environmental degradation for Turkey. The study proposed new strategy that can reduce the deterioration in income distribution in fight against the overtime reduction in the environmental quality. Similarly, Batur et al (2019) examined the effects of production and consumption policies on energy consumption and CO2 emissions for Istanbul, Turkey. They found that the twin policies have a significant negative impact on CO2 emissions and energy consumption. It is important for policy makers and researchers in oil producing economies to adopt a way of investing massively in the promotion of carbon-reducing technology in productive activities as part of the struggle for economic growth and development (Awodumi & Adewuyi, 2020). Movement of Nigeria from the use of fossil fuels and firewood to liquefied petroleum gas (LPG) for cooking will considerably reduce air pollutants internally but will increase CO2 emissions by 2050 (Dioha & Kumar, 2020)

2.2 Environmental regulation and environmental quality nexus in other regions

This section specifically focuses on relevant studies in the literature on other economic region on the nexus between environmental regulation and environmental quality. It has been made evident that few studies have explored the linkage between environmental regulation and environmental quality on BRICS economies which include Brazil, Russia, India, China and South Africa and the results are found to be inconsistent. For example, Tamazian et al (2009) proposed the need for environmental policies that can be adopted for CO2 emission reduction in BRICS after examining the impacts of financial and economic development on environmental quality using a panel data from 1992 to 2014 and they discovered that higher degree of financial development and economic development improves the environmental quality of BRICS economies. Also, Zakarya et al (2015) recommended regulations to deal with threat of CO2 emissions after discovering a unidirectional causality from CO2 to the economic variables employed in the study on BRICS. Using data envelopment analysis(DEA) approach, Chang (2015) compared the level of progress of carbon emission reduction in G7 and BRICS economies before and after 2005. It was discovered that G7 countries recorded greater improvement before 2005 while BRICS economies achieved greater improvement after 2005 and this is as a result of the stringent policies placed to improve environmental quality in each of the regions. Nassani et al (2017) confirmed the urgent need for green policy instruments as part of the policies to enhance growth of BRICS economies as a result of the existence of Environmental Kuznets curve (EKC) hypothesis discovered in the study covering a consistent time series data from 1990 to 2015. Yilanci et al (2019) employed Autoregressive Distributed Lag (ARDL) to examine the impacts of foreign direct investment (FDI) and trade openness on clean energy consumption for BRICS economics over the period from 1985 to 2017. They found the impacts to be mixed and inconsistent among the countries. Danish et al (2019) also explicitly investigated the role of governance on environmental quality in BRICS economies for a panel data from 1996 to 2017. It was discovered in the study that governance has statistically significant negative impacts on CO2 emission as it leads to Environmental Kuznets Curve hypothesis and reduces CO2 emissions in the economies.

Furthermore, Khan et al (2019) investigated the efficiency of environmental regulations in mitigating carbon emissions in BRICS over the period spanning from 1995 to 2016 by employing Common Correlated Effects Mean Group (MG-CCE) estimator. The study concluded that economic development is not enough to drive the mitigation of climatic change but also by the adoption of effective environmental regulations. In another study conducted by Adedoyin et al (2020a) examined the relevance of coal rent regulation in the modelling of the nexus between economic growth and CO2 emission for BRICS economies for the period between 1990 and 2014. From the ARDL techniques applied in the study, it was discovered that regulations on coal rents in terms of carbon damage costs have a significant positive effect on CO2 emissions which makes it inevitable for the adoption of more strict environmental-energy-related regulations.

While the above studies only talk about BRICS economics in panel data form, there are also recent studies that examine BRICS countries individually. For example, Yin et al (2015) considered the effects of environmental regulations and technical progress in China over the period from 1999 to 2012. They discovered that stricter environmental regulations hasten the reduction of carbon emissions than that of technical progress has minute effect on carbon emissions reductions. Ma et al (2019) examined the impacts of government regulations on energy and carbon emissions in mining industry of 29 provinces in China over the period from 2005 to 2014. The result from the empirical study shows that the stringent regulations of the government undermine the efficient performance of mining industry. Wang et al (2019) carried out an empirical analysis on the effects of environmental regulations on the choice of locations of polluting firms in China. It was discovered in the study that there are contradictory impacts of environmental regulation on location choices for heterogeneous firms.

Samimi et al. (2012) examined the impacts of three major indicators of governance (government effectiveness, regulatory quality and control of corruption) on environmental degradation in 21 countries in MENA region over the period of 2002-2007.They found that better governance has positive impact on environmental quality. Goel et al. (2013) employed data of over 100 countries in MENA region over the period 2004-200 investigate the impact of institutional quality on environmental pollution. They found that MENA nations are more exposed to environmental pollution with the level of institutional quality. Al-Mulali & Ozturk, (2015) concluded on their study on MENA region that energy consumption, urbanization, trade openness and industrial development increases environmental degradation in the region while stable political atmosphere decreases in the long run. Abdouli & Hammami, (2017) found a feedback causal relationship between economic growth and CO2 emissions and FDI stocks and CO2 emissions in 17 MENA economies over the period 1990-2012. The study recommended policies that can be adopted to reduce the rate of carbon emissions in the region. Similarly, Charfeddine & Mrabet, (2017) carried out an empirical analysis of the effects of economic development and socio-political factors on ecological footprint for 15 countries in MENA region. The study suggested that improvement of political institutions will improve the environmental quality in the region.

Furthermore, Aşıcı & Acar (2018) investigated how choice of production location of non-carbon ecological footprint is affected by environmental regulations for 87 countries in MENA region for the period 2004-2010 within the framework of Environmental Kuznets Curve (EKC) hypothesis. It was discovered in the study that enforcement of environmental regulations pushes the countries towards cleaner environment. The result of Mahlooji et al (2019) shows the necessity of the MENA region to adopt electricity mix to reduce the impacts of climatic change in the region in terms of resource availability conditions. As shown by Gorus & Aslan, (2019) that foreign direct investment inflows and energy use have worsened environmental pollution in the majority of MENA countries thereby call for strict environmental regulations to improve the environmental quality of the region. The study of Nathaniel & Nathaniel (2020) disregards the importance of renewable energy as it is revealed in the study that that renewable energy does not significantly improve the environmental quality though non-renewable energy worsens the problem environmental degradation in MENA region and therefore proposed in the study that the region should concentrate on embracing cleaner energy sources.

3. Data, Method, and Models

3.2 Data

The study adopted annual time series data for four MINT countries spanning 1980-2016. The time period was limited by data availability. For information relating to measurement and sources of the data, see Table 1.

Table 1: Data Source and Measurement

S/N	Indicator Name	Measurement	Source
1	Energy use	kg of oil equivalent per capita	WDI (2019)
2	Trade	Sum of import and export as % of GDP	WDI (2019)
3	GDP Per Capita	in constant 2010 USD	WDI (2019)
4	Ecological Footprint	global hectares per capita	GFN (2019)
5	Environmental Regulation	patents on environment technologies	OECD(2019)

Note: GFN represents Global Footprint Network.
Sources: Author's compilation.

3.2 Method and Models

The first point of call was to check for CD. This test (CD) is important because it gives direction on the econometric techniques to adopt. Once CD is ignored, the estimators will not be robust, and the outcomes will be biased. The null hypothesis of the CD test is shown in Eq 1.

$$H_0: \rho_{ij} = corr(\mu_{it}, \mu_{jt}) = 0 \; \forall \; i \neq j \tag{1}$$

The presence of CD will inform the use of second-generation estimation techniques since the conventional unit root (Levin-Lin & Chu 2002; Im et al. 2003), cointegration, and causality tests may not be efficient amidst CD. The CD augmented IPS (CIPS) test of Pesaran (2007) which accounts for CD is adopted to ascertain the unit root properties of the variables. See Eq.2 for the test equation.

$$\Delta y_{it} = \varphi_i + \beta_i y_{i,t-1} + \tau_i \bar{y}_{t-1} + d_i \Delta \bar{y}_t + \varepsilon_{it} \tag{2}$$

The sample average of Eq. 2 yields the CIPS statistic. If the variables are all integrated of the same order I(1), the study will rely on the Westerlund (2007) test for any evidence of cointegration by estimating Eq. 3.

$$\Delta y_{it} = \delta_i' d_t + \alpha_i y_{it-1} + \lambda_i' x_{it-1} + \sum_{j=1}^{pi} \alpha_{ij} \Delta y_{it-j} + \sum_{j=0}^{pi} \gamma_{ij} \Delta x_{it-j} + e_{it} \quad (3)$$

Eq. 3 is the error correction approach of the Westerlund (2007) test. The deterministic component, vector and error parameters are $d_t = (1, t)'$, $\delta_t = (\delta_{i1}, \delta_{i2})'$, and α_i respectively. The OLS estimates of α_i will generate for tests which will either confirm or reject the existence of cointegration. Of the four tests, are the group mean statistics:

$$G_\tau = \frac{1}{N}\sum_{i=1}^{N} \frac{\widehat{\alpha_i}}{SE(\widehat{\alpha_i})} \qquad \text{and} \qquad G_\alpha = \frac{1}{N}\sum_{i=1}^{N} \frac{T\,\widehat{\alpha_i}}{\widehat{\alpha_i}(1)}$$

With $SE(\widehat{\alpha_i})$ representing the standard error of $\widehat{\alpha_i}$, while $\widehat{\alpha_i}(1)$ is the semiparametric kernel estimator of $\alpha_i(1)$. The panel mean tests are the remaining two. These tests assumed the cointegration of the whole panel.

$$P_\tau = \frac{\widehat{\alpha_i}}{SE(\widehat{\alpha_i})} \qquad \text{and} \qquad P_\alpha = T\hat{\alpha}$$

To account for CD, a battery of econometric techniques was used to examine the effects of each of the variables on the explained variable. The Prais-Winsten, along with the Driscoll-Kraay (DK) panel-corrected standard errors approach were used for this purpose. Both techniques address the problem associated with CD. The DK technique requires taking the average of the products between the residuals and the explanatory variables which will be used in a weighted HAC estimator to derive standard errors with a plausible property of being robust against CD (Jalil, 2014). The DK technique is a non-parametric approach. It is flexible. It accommodates large time dimension, missing values, suitable for both unbalanced and balance panel and is also superior amidst spatial and serial dependence and heteroscedasticity (Sarkodie and Strezov 2019; Ozokcu et al. 2017). The DK equation is given as:

$$y_{i,t} = x'_{i,t}\beta + \varepsilon_{i,t}, i = 1, \dots, N, t = 1, \dots, T \quad (4)$$

The scalar $y_{i,t}$ represents EFP; the dependent variable, while $x'_{i,t}$ represents (trade, GDP, GDPsq, energy use, and environmental regulation) the independent variables. On the other hand, the Prais-Winsten regression was also preferred for its robustness in the presence of serial correlation, heteroskedastic, and CD. The FMOLS and the DOLS were used for robustness check. The DOLS equation to be estimated, building from recent studies of Hashmi and Alam (2019), Albulescu et al. (2019), Ouyang et al. (2019), and Ulucak et al. (2020) is given as:

$$EFP_{it} = \mu_i + x_{i,t}\Psi_{i,t} + \sum_{j=-p}^{p} \beta_j EFP_{i.t-j} + \sum_{j=-q0}^{q0} p_{1.j} TRD_{i.t-j} + p_{2.j} \sum_{j=-q1}^{q1} GDP_{i.t-j} + p_{3.j} \sum_{j=-q2}^{q2} GDPsq_{i.t-j} + p_{4.j} \sum_{j=-q3}^{q3} EUS_{i.t-j} + p_{5.j} \sum_{j=-q4}^{q4} ERT_{i.t-j} + \varepsilon_{it} \quad (5)$$

Where EFP, TRD, GDP, GDPsq, EUS and ERT are ecological footprint, trade, gross domestic producer, the square of GDP and environmental regulation respectively. p and q represent the number of lags/leads of the explained and explanatory variables, and ε_{it} is the error term. The FMOLS equation is expressed as:

$$EFP = \mu_i + x_{i.t}\psi + v_{it} \quad (6)$$

$$x_{i.t} = x_{i.t} + \mathfrak{C}_{i.t}$$

Where x is 5*1 vector of explanatory variables, with μ_i as the intercept, while v_{it} and $\mathfrak{C}_{i.t}$ are the disturbance terms. The estimation of ψ is expressed as:

$$\hat{\psi}_{FMOLS} = \left(\sum_{i=1}^{N}\sum_{t=1}^{T}(x_{i.t} - \bar{x}_{i.t}) * (x_{i.t} - \bar{x}_{i.t})'\right)^{-1} * \left(\sum_{i=1}^{N} \left(\sum_{t=1}^{T}(x_{i.t} - \bar{x}_{i.t}) * \widehat{EFP}_{it} - T\hat{\Delta}_{v\mathfrak{C}}\right)\right) \quad (7)$$

4. Results and Discussion of Findings

Table 2: Descriptive Statistic and Correlation

	EFP	GDP	GDPsq	TRD	EUS	ERT
Mean	19.10	8.291	13.08	3.820	6.828	2.294
Max.	19.90	9.551	17.20	4.566	7.414	4.199

Mini.	18.22	7.115	9.550	2.838	5.934	0.912
Std. D	0.425	0.788	2.456	0.319	0.397	0.611
Correlation						
ERT	-0.102	-0.131	-0.155	-0.205	-0.118	1.000
EUS	0.243	0.270	0.368	-0.037	1.000	
TRD	0.349	-0.139	-0.208	1.000		
GDPsq	0.325	0.577	1.000			
GDP	0.299	1.000				
EFP	1.000					

Source: Author's computations.

The results from Table 2 suggest that GDPsq has the highest average value, and also the most volatile of all the variables. ERT has the lowest average with 2.294, while EFP is the least volatile of the variables. All the variables are positively associated with EFP except ERT. EUS and ERT have a positive correlation with TRD, and EUS is negatively associated with ERT.

Table 3: Cross-sectional Dependence Test

Variables	*Breusch-Pagan LM*	*Pesaran scaled LM*	*Pesaran CD*
Ecological Footprint (log)	187.5666***	54.41376***	13.67215***
GDP (log)	167.6245***	46.65698***	12.91369***
GDP squared (log)	156.9958***	43.58872***	12.47470***
Trade (log)	41.24955***	10.17567***	4.502822***
Energy Use (log)	95.92768***	25.95989***	9.557898***
Enviro. Regulation (log)	15.76772**	2.819699***	1.285553

Note: *** and ** imply statistical significance at 1% and 5% levels
Source: Author's computation

The findings from Table 3 confirm the presence of CSD. It was this results that informed the adoption of unit root tests, mainly second-generation (CIPS and CADF), that give robust results amidst CADF since the first-generation tests may not be efficient in the presence of CSD. The results of the unit root tests (see Table 4), affirmed that the variables are I(1). This is enough evidence to proceed with a test for a long-run relationship.

Table 4: Panel Unit Root Tests

Variables	*Level*	*First Difference*

	CIPS	CADF	CIPS	CADF
EFP (log)	-2.056	21.34	-6.140***	112.3***
GDP (log)	-1.759	17.11	-4.948***	45.87***
GDPsq. (log)	-3.269	15.09	-4.835***	50.21***
EUS (log)	-4.355	32.32	-6.190***	44.43***
TRD (log)	-1.491	30.22	-5.557***	87.43***
ERT (log)	-5.133	41.03	-6.075***	76.67***

Source: Authors' Computations

There are various cointegration tests, but we settled for the Westerlund (2007) test because of it gives robust and efficient estimates even in the presence of CSD. The results of the test are presented in Table 4. From the results, we cannot deny the presence of a long-run relationship among the variables. The presence of a long-run relationship informed the use of techniques such as the FMOLS and DOLS that show the effect(s) of each of the variables on the dependent variable (EFP) in the long run.

Table 5: Panel Cointegration Test (Westerlund)

Statistic	Value	Robust P-value
Gt	-2.462	0.920
Ga	-25.21**	0.004
Pt	-3.549*	0.092
Pa	-21.76**	0.010

Source: Author's computation.
Note: * and ** show significance at 10% and 5% levels.

The three regression results (PCSE, PCSE No Autocorrelation and the Driscoll/Kraay) in Table 6, provided consistent outcomes. The three tests are in harmony. The results consistently showed that economic growth is detrimental to the environment in MINT countries. These results were expected as MINT countries are still developing. At the initial stage of development, growth is expected to impact negatively on the environment because, countries will shift their focus to policies and programs that can yield more growth, and possibly lead to development with less attention on the quality of the environment. This finding is in consonance with previous studies such as Ulucak et al. (2020), Ahmed et al. (2020) and Liu et al. (2020), Raza et al. (2020), and Nathaniel et al. (2020) for BRICS, G7, N-11, and MENA countries respectively.

Table 6: Panel-Corrected Standard Errors Results

Variables	*PCSE AR(1) Process*	*PCSE No Autocorrelation*	*Driscoll/Kraay*
Constant	-4.2742	-4.2742	-8.7217***
	(-0.73)	(-0.66)	(-1.29)
GDP (log)	3.9466***	3.9466***	5.8675**
	(2.98)	(2.68)	(3.76)
GDP squared (log)	-1.2707***	-1.2707***	-1.8165**
	(-2.94)	(-2.65)	(-3.64)
Trade (log)	0.3187***	0.3187***	0.7334***
	(4.30)	(3.96)	(8.08)
Energy use (log)	0.8708***	0.8708***	0.0320***
	(4.29)	(4.56)	(2.59)
Enviro. regulation (log)	-0.0094	-0.0094	-0.0119
	(-0.35)	(-0.33)	(-0.20)
R-squared	0.9989	0.9989	0.4842
No. of observations	119	119	119
No. of groups	4	4	4

Note: *** and ** represent statistical significance at the 1% and 5% levels of significance respectively. *t*-statistics are in parentheses.
Source: Authors' Computations

The negative coefficient of GDPsq does not only confirms the existence of the EKC hypothesis, but also reaffirm that these countries are still at their initial stage of development. Even the United Nations classified the MINT countries as developing countries (see http://unstats.un.org/unsd/methodology/m49/, accessed on 3 April 2020). The results further revealed the EUS adds to environmental degradation. At the early stage of development, more energy is consumed to meet up with household and industrial requirements. The energy mix of MINT countries is largely nonrenewable (NRE). NRE sources like uranium, crude oil, natural gas, and coal which are mostly consumed in these countries, are rich in emissions. They are pollutants that truncates environmental sustainability. For instance, Nigeria's is not only the largest economy in Africa, but also the largest gas producer and consumer in West Africa. About 80% of electric power generation emanates from gas, while the remainder comes from oil (IEA, 2019). More than 1% of the world's total GHGs are emitted by Turkey yearly amounting to 500 megatonnes. Oil, coal, and natural gas accounted for 35.6%, 12.3%, and 2.6% of the final energy consumption in Turkey respectively in 2014 (IEA, 2016). Expectedly, the energy sector was responsible for 86.1% of CO_2 emissions in 2016 (Turkish Statistical Institute, 2018). The Living Planet Report (LPR) of 2014 showed that Indonesia's EFP fall shut of the world's average (1.7 gha) biocapacity per person. This could be as a result of the country's persistent consumption of NRE. Even Mexico consume more of fossils fuel than renewables despite its renewable energy potentials (IEA, 2018). Gorus and Aydin (2019), Al-Mulali and Che Sab (2018), and Gorus and Aslan (2019) reported a similar trend for MENA, Sinha et al. (2019) for BRICS and the Next-11 countries, and Nathaniel and Iheonu (2019), Ssali et al. (2019), and Esso and Keho (2016) for SSA.

Trade was further revealed as another variable that reduces environmental quality in MINT. Inadequate clean technology transfer due to trade expansion could be a plausible reason. Another reason could be weak environmental policies/regulations which are not stringent enough to stall the importation of dirty technologies and good in these countries. The coefficient of ERT is negative. This suggests that ERT contributes to environmental preservation in MINT. ERT clearly promotes technological innovation (Guo et al., 2017). Technological innovation, on the other hand, declines emissions and uphold energy efficiency. A careful look at Table 5 revealed that EUS and GDP have a higher coefficient than ERT. Also, it is clear that the additive effects of the aforementioned variables will dominant the negative effect of ERT. Therefore, one might claim that the potency or efficiency of ERT towards environmental preservation is lower in MINT. However, to ensure the preservation and sustainability of the environment in MINT, there is a need to strengthen ERT in relation to permission of technological transmission and the acquisition of intellectual property rights. In MINT, trade and economic growth alone are not efficient in reducing the EFP but coupled with ERT can yield a reverse outcome. The efficiency of ERT in enhancing environmental quality have earlier been reported by (Ulucak et al. 2020; Zhang 2019; Cheng et al. 2019; Pei et al. 2019; Hashmi & Alam 2019; Ouyang et al. 2019; Wang et al. 2019; Wenbo and Yan 2018; Li and Ramanathan 2018; Cheng et al. 2017), while Hao et al. (2018) discovered that ERT has no meaningful role in abating pollution.

Table 7: Robustness Check with FMOLS and DOLS

Variables	*FMOLS*	*DOLS*
GDP (log)	0.6576*** (12.875)	0.6680*** (17.992)
GDP squared (log)	-0.5921***(-2.9587)	-0.5764*** (-4.2870)
Trade (log)	0.1255*** (5.6583)	0.1001*** (5.5338)
Energy use (log)	0.1097*** (4.9921)	0.1131** (2.2018)
Enviro. Regulation (log)	-0.4225 (-1.2163)	-0.3207 (-1.6261)

Note: *** and ** represent statistical significance at 1% and 5% respectively.
Source: Authors' Computations

Table 7 confirmed the robustness of our findings in Table 6. Each of the variables exhibited the same sign with the already discussed results in Table 6. Therefore, similar explanation applies. The country specific results via the FMOLS are shown in Table 8. From the results, energy consumption increases the EFP in all MINT countries. The same influence is exacted by trade on the EFP, except in Turkey. This outcome could be attributed to the clean technological transfer in Turkey, or perhaps, an improvement in ERT that have resulted in 'green trade' with the outside world. The abating role ERT on environmental degradation was confirmed in all the countries. It was significant in Nigeria and Turkey but remained insignificant in Mexico and Indonesia. Economic growth appears to be detrimental to the environment in Mexico and Turkey, but not in Nigeria and Indonesia. We further discovered the existence of the EKC hypothesis in Mexico and Turkey, but same was not true in Nigeria and Indonesia.

Table 8: Country-wise FMOLS results

	ln(GDP)	ln(GDPsq)	ln(TRD)	ln(EUS)	ln(ERT)	EKC?
Regressors	Coeff (t-stat)	Coeff (t-stat)	Coeff (t-stat)	Coeff (t-stat)	Coeff (t-stat)	
MEXICO	0.14 (6.88)	-0.04 (-6.83)	0.50 (12.30)	0.04 (0.19)	-0.00 (-0.22)	**YES**

INDONESIA	-5.15 (-5.37)	1.91 (5.99)	0.05 (1.96)	0.52 (7.79)	-0.01 (-0.53)	**NO**
NIGERIA	-9.98 (-4.24)	3.64 (4.37)	0.23 (11.33)	3.93 (17.73)	-0.04 (-4.71)	**NO**
TURKEY	8.58 (13.06)	-2.37 (-13.00)	-0.10 (-5.97)	0.77 (13.54)	-0.01 (-2.79)	**YES**

Source: Authors' Computations.

Table 9: Dumitrescu & Hurlin Causality Results

Null Hypothesis:	*W-Stat.*	*Zbar-Stat.*	*Prob.*	*Conclusion*
GDP ≠> EFP	2.48838	1.80076	0.0717	Bidirectional causality
EFP ≠> GDP	9.89587	11.1690	0.0000	
GDPsq ≠> EFP	3.07913	2.54788	0.0108	Bidirectional causality
EFP ≠> GDPsq	10.0276	11.3356	0.0000	
TRD ≠> EFP	5.20658	5.23845	2.E-07	No causality
EFP ≠> TRD	1.34735	0.35770	0.7206	
EUS ≠> EFP	1.97753	1.15468	0.2482	No causality
EFP ≠> EUS	1.96122	1.13406	0.2568	
ERT ≠> EFP	0.56030	-0.63768	0.5237	Unidirectional causality
EFP ≠> ERT	2.41182	1.70393	0.0884	
TRD ≠> GDP	5.47762	5.58124	2.E-08	No causality
GDP ≠> TRD	1.43937	0.47407	0.6354	
EUS ≠> TRD	0.96980	-0.11979	0.9047	Unidirectional causality
TRD ≠> EUS	2.87950	2.29540	0.0217	
ERT ≠> EUS	0.29735	-0.97024	0.3319	Unidirectional causality
EUS ≠> ERT	2.59004	1.92933	0.0537	
ERT ≠> TRD	0.28107	-0.99082	0.3218	No causality
TRD ≠> ERT	7.16919	7.72057	1.E-14	
EUS ≠> GDP	1.12036	0.07062	0.9437	No causality
GDP ≠> EUS	5.74599	5.92065	3.E-09	

Note: ≠> represents "does not homogeneously cause."
Source: Authors' Computations

Since effect is quite different from causation, the causality test becomes germane to aid policy formation and direction. Table 9 revealed a feedback causality between GDP and EFP, and between GDPsq and EFP. These findings reaffirm the negative impact of economic growth on environmental quality as it pertains to a developing country. It is a confirmation that developing countries, MINT inclusive, tend to ignore the quality of the environmental at the initial stage of development. Their focus is mainly on how to attain more growth and probably make it sustainable. But growth is hardly sustainable when the quality of the environment is ignored. A unidirectional causality flow from ERT to EFP. This shows the possibility of ERT to promote ecological distortions and calls for the strengthening of environmental regulations. The strengthening of ERT will assist the MINT countries to achieve optimum income especially when pollution begins to decline.

5. Conclusion

This study examined the trade-off between environmental regulations and EF in MINT for the period 1980-2016 with trade, economic growth, and energy consumption as the other explanatory variables. The study relied mainly on second-generation econometric techniques due to the presence of CD. The FMOLS and DOLS were used to confirm the robustness of the results. The findings were consistent across board. Energy consumption, trade and economic growth promote environmental degradation, while environmental regulations is less potent in its abating role. These findings, of course, call for policy directions that will necessitate the attainment of the SDGs by 2030.

Energy consumption consistently declines environmental quality across board. This calls for an adjustment in the energy portfolio of these countries. There is the need to increase the share of renewables (wind, solar, hydropower, tide, geothermal, hydropower, etc.) as these energy sources are clean, unlike fossil fuels that are pollutants. An improvement in technologies that are environmental-friendly will also go a long way in curtailing emission and enhancing economic growth. Increasing the share of renewables may not be an easy task for these countries, but they can start by improving their regulatory standards in relation to renewable energy technologies. Emphasis should be on property rights, environmental taxes, and the removal of harmful subsidies. Once this is done, obnoxious environmental externalities will be internalized and the attainment of SDG-7 (Affordable and Clean Energy) will be feasible for MINT countries. An improving in regulatory standards is not enough, the need for policymakers to improve environmental awareness and enforce clean production process is also sacrosanct. There can be a smooth transition with less or no harm to the already existing growth pattern in MINT countries. These could be achieved if the households have access to tax rebate, highly subsidized loan, and interest rate holiday as palliatives to encourage the consumption of renewables. Thereby opening the pathways to making communities and societies sustainable (SDG-11). If highly polluting firms are made to pay a higher environmental tax and interest rate due to the negative externalities they create, it will serve a little more than an incentive to the cleaner industries, which will initiate a clean production process; a pathway to clean water and sanitation (SDG-6) which comes with good health and wellbeing (SDG-3).

Previous studies have echoed the role of environmental regulations in abating pollution and ensuring environmental sustainability. However, the results from this study consistently revealed that MINT countries, in general, have weak environmental regulations. Therefore, we strongly recommend stringent environmental regulations in MINT as a panacea for environmental deterioration. Also, MINT countries may have to strengthen their ERT as foreign trade seems to be on a rise in these countries. Specifically, Mexico, Indonesia, and Nigeria need to revise their ERT for trade activities. As trade brings polluted good and technology which can be overcome by stringent ERT. Data availability was one of the limitations of this study. Also, some components of EFP were not considered. We used econometric techniques that suit the characteristics of the data. Future studies could leverage on these limitations by considering other potential indicators of environmental degradation like globalization, urbanization, ICT, etc. The same study can be replicated for other region with more advanced econometric techniques.

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