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The Role of Educating the Labor Force in Sustaining a Green Economy in MINT Countries: Panel Symmetric and Asymmetric Approach

Nihal Ahmed [1,*], Adnan Ahmed Sheikh [2], Bilal Hassan [3,4], Sajjad Nawaz Khan [5], Ricardo Cosio Borda [6], Juan Martín Campos Huamán [6] and Piotr Senkus [7]

1 Orléans Institute of Economics, Orléans University, CNRS, LEO, FRE, 2014, F-45067 Orléans, France
2 Department of Business Administration, Air University Multan Campus, Multan 59300, Pakistan
3 Institute of Management Science, Bahauddin Zakariya University, Multan 59300, Pakistan
4 Department of Business Administration, Air University Islamabad, Multan Campus, Multan 59300, Pakistan
5 Department of Management Sciences, The Islamia University Bawalpur, Bawalpur 63100, Pakistan
6 Faculty of Management Sciences, Universidad César Vallejo, Lima 5002, Peru
7 Faculty of Social Sciences, Siedlce University of Natural Sciences and Humanities, 08-119 Siedlce, Poland
* Correspondence: nihalahmad.nak99@gmail.com

Abstract: Over the years, the economies of Mexico, Indonesia, Nigeria, and Turkey (the MINT countries) have had significant levels of economic growth. However, these countries have not been able to protect the quality of their environments simultaneously. As a result, the rising environmental indices in these nations cast a gloomy shadow over their capacity to continue their economic development. It has been shown that a more educated workforce may boost an economy's absorption capacity and enhance the efficiency of green technology, both of which contribute to lower emissions of greenhouse gases. This article reports on research that examines the link between educating the labor force and environmental sustainability in the MINT economies. In order to conduct an empirical analysis of the data spanning the years 1995–2020, panel ARDL-PMG and NARDL-PMG techniques were used. First, the results of the ARDL-PMG demonstrate that a more highly educated workforce plays a vital role in mitigating CO_2 emissions. Moreover, the NARDL-PMG's results demonstrate that a positive component of a highly educated workforce is a large negative influence on CO_2 emissions, whereas in the long run, the negative component of a highly educated workforce has a positive impact on CO_2 emissions over time. This article recommends that the MINT nations' authorities boost education and training for their workforces in order to keep CO_2 emissions down.

Keywords: labor economics; sustainability; public policy; human resources; green processed; green economy; SDGs

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1. Introduction

Mexico, Indonesia, Nigeria, and Turkey (the MINT countries) have practiced significant levels of economic growth over the years, and it has been predicted that they will play a significant role in international economic relations [1]. There are several similarities among the MINT countries, such as the fact that they have large, young, and growing populations. Another feature is their proximity to Western economies. For example, Indonesia, China, Turkey, Mexico, and Nigeria are all within a few hundred miles of each other, and Nigeria is Africa's economic rallying point [2]. Nigeria is the only one of the four MINT countries that does not belong to the G20 group, which includes both developed and developing countries. However, Nigeria's abundance of natural resources, mainly crude oil, gives it an advantage [1].

The MINT countries were identified by Goldman Sachs in 2012, when they were ranked as the world's 14th, 16th, 39th, and 17th economies, respectively [2,3]. Despite this,

Mexico was ranked 15th, Indonesia was 16th, Nigeria was 31st, and Turkey was ranked 18th in the World Bank's 2018 economic rankings [4]. A similar report predicted that by 2023, all four MINT nations—Mexico, Indonesia, Nigeria, and Turkey—will be in the world's top 20, with Mexico ranking 15th, Indonesia 16th, Nigeria 20th, and Turkey 17th. Despite the abundance of opportunities in the MINT nations, their economic expansion will be accompanied by a number of obstacles, including urbanization, energy consumption, and environmental degradation [3].

The temperature of the world has increased as a direct result of the vast carbon emissions that have been caused by the social and economic activities of human beings [5]. The reliance of humanity on energy sources, including gas, oil, and coal, which are non-renewable energy sources, is the primary contributor to the current increase in temperature that has been caused by the vast emissions of carbon dioxide. However, affluent economies and developing economies have not yet come to a unified global policy to address this threat, despite the fact that global warming is getting more severe and is an emerging issue on the world stage. In this context, individual nations and their separate heads of state have implemented a variety of policies and tactics to control and reduce the amount of carbon dioxide (CO_2) emissions that are being released into the environment [6]. In order to achieve their sustainable development goals (SDGs), policy makers are implementing structural changes in their economic and social systems, establishing new sets of environmental regulation standards, and placing a greater emphasis on the utilization of renewable energy sources (such as hydro, nuclear, biofuel, and wind) and improving environmental sustainability by incorporating new, environmentally friendly technology into the manufacturing and consumption processes [7,8]. These regulations will, in the long term, not only be beneficial to the environment but will also help reduce dependency on energy sources that are not renewable. In addition to these rules and regulations, bringing more attention to the issue of pollution in the environment and teaching people about the advantages of maintaining a healthier and more verdant ecology for the next generations could also be helpful to combat the environmental pollution [9]. Within this framework, the government, together with the assistance of the media and civil society, is tasked with addressing the issues at hand, and should organize events such as conferences and workshops that might imbue the participants and the entire public with moral preaching and environmental instruction. This would ultimately result in bringing more attention to the issue of the environment and the issues that are related to it [10,11].

As the energy demand is increased due to economic activities, which in turn contributes to environmental pollution, the essential goal for nations that are still emerging from poverty, and still in the process of developing, is to keep carbon emissions under control while maintaining a healthy rate of economic growth [12,13]. It is easier to observe this occurrence in countries with middle- and low-income economies, mainly due to the fact that it is difficult for these countries to slow the rate at which carbon emissions are rising while keeping up the same level of economic activity. This is because the structures of their social, business and economic systems use conventional techniques. "The environment Kuznets curve (EKC) is an inverted U-shaped curve that observes the linkage between economic growth and environmental quality" has been developed by Grossman and Krueger [14]. They have concluded that early economic growth has seen a rise in CO_2 emissions throughout the process of economic development, and, after the growth has solidified, a drop in CO_2 emissions will be observed. This was observed during both stages of economic development. Subsequently, several academics and policymakers have validated an inverted U-shape curve for a variety of areas and nations [8,15]. This theory has garnered much interest because of its potential implications. Environmentalists have recently switched their attention away from low-skilled and uneducated workers and toward higher-skilled workers' reduction in greenhouse gas (GHG) emissions via the EKC hypothesis, which takes into account factors such as an educated labor force and human capital. Figure 1 provides the graph of carbon dioxide emissions for the MINT countries.

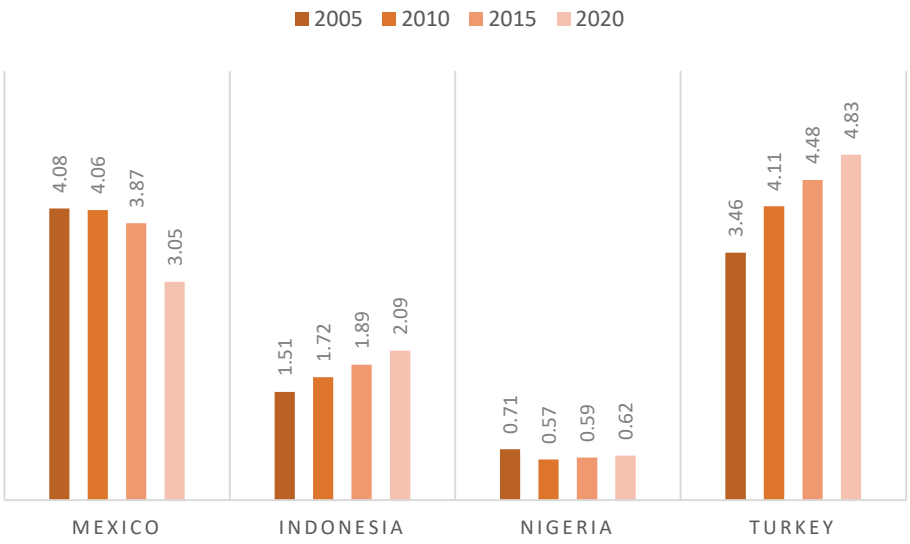

Figure 1. Carbon dioxide emission (metric tonnes per capita) Source: World Data Atlas [16].

Environmentalists' priorities have evolved away from the uneducated or unskilled labor force and its role in reducing CO_2 emissions by taking into account the factors of human capital and an educated labor force in the EKC hypothesis [17].

It makes sense to consider a skilled labor force, knowledge, and education as factors in determining carbon emissions. This is due to the fact that education contributes to the expansion process, which is one of the primary contributors to air pollution. According to [18], a considerable portion of the female workforce is engaged in the shift to cleaner energy sources in households, which has resulted in a decrease in environmental pollution. According to [19], an educated workforce is more likely to employ contemporary fuels than biomass energy. Figure 2 details the percentage of the labor force with advanced education.

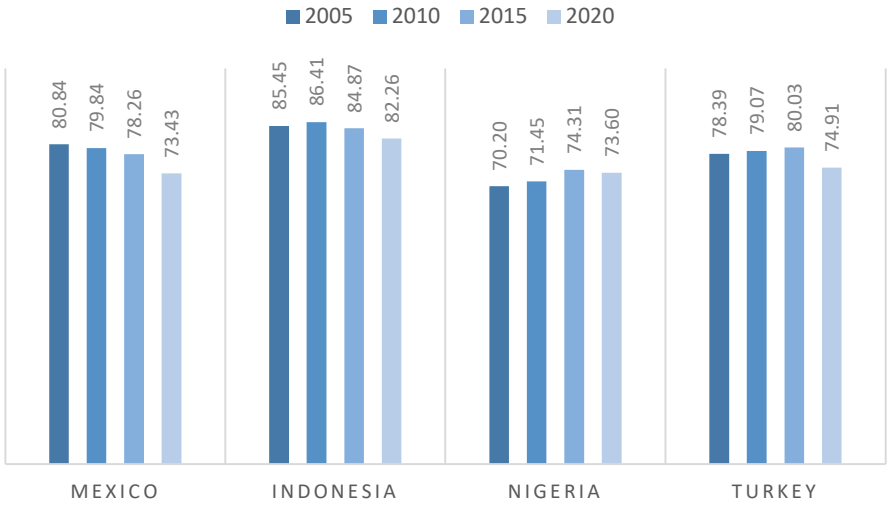

Figure 2. Educated labor force (percentage of the labor force with advanced education) Source: World Development Indicators [20].

According to the endogenous growth hypothesis, knowledge may be a crucial input in the manufacturing process that adds to a nation's long-term economic progress [21,22]. Evidence suggests a substantial positive relationship between economic growth and a nation's human capital. Human capital can be developed with professional courses and certificates, formal education, skill improvement programs, and research and training, which are regarded as significant production function inputs [23,24]. The industrialized economies have entirely shifted their manufacturing processes from labor-intensive to skill-intensive,

which has altered their economic picture and allowed them to expand continuously over a more extended period of time in an environmentally friendly manner. The influence of any policy or action does not remain restricted to the borders of a single nation; rather, the spillover effects travel throughout the globe as the world is interconnected. In this case, the pressure on developing countries to include human-capital-intensive approaches, which will not only help them to develop, but will also allow them to do so in a way that is not harmful to the environment, might increase [6,25]. The greater expected degree of final recovery affects economic performance [11]. Changes in water resource usage affect the creation of pollutants and gases [11,26–28]. The sense of community also aids in maintaining the level of pollution [12,29]. Increased economic development accelerates environmental deterioration [30]. The literature shows that the accumulation of education may also have a significant impact on the quality of the environment. Karakul [28] has developed some theoretical arguments on green economies, in which they have acknowledged the significance of teaching workers about the environment. According to Dedeoğlu and Koçak [31], the accumulation of education is a slow and gradual process that has an indirect impact on the surrounding environment. Functions that can be attributed to education include social, cultural, political-ideological, and economical. Education serves several important societal tasks, including one that has a beneficial influence on the green economy. The research that supports the relationship between education and the environment is based on the endogenous growth hypothesis.

Both industrialized and developing nations are under increasing pressure to speed up the transition to a cleaner, greener economy, due to the increasing focus on environmentally sustainable development models that reduce their carbon footprints. Education, skill building, and talent cultivation are all levers that may hasten and solidify this shift. The shift to greener economies calls for both highly trained professionals and skilled tradespeople. A competent or educated workforce is a crucial element to curb the rising CO_2 emissions [28]. This study differs from [29,32], who have said that higher education is crucial to the development of a green economy. Ref. [33] has observed that informed and competent labor forces have had a negative effect on the intensity of CO_2 emissions in China. In addition, a competent and educated work population generates a knowledge spillover effect and promotes the spread of low-carbon technologies.

The objective of this research is to investigate the importance of a well-educated workforce to the successful management of the green economy in the MINT countries. To achieve this objective, the study employs a NARDL-PMG for the time period from 1995 to 2020. In today's environment, when macroeconomic variables are prone to cyclical fluctuations, the nonlinear method of analysis is more applicable. The NARDL-PMG allows us to decompose the primary variables into their positive and negative shocks, allowing us to capture the influence of each variable on our dependent variable, independently. Innovation, a skilled labor force, energy investment, and environmental concerns must be addressed with the aforementioned factors.

The rest of the paper comprises three sections: Section 2, "Materials and Methods", which describes the data and model specifications; Section 3, "Results and Discussion", which discusses the results of the study; and the last section, "Conclusions and Policy Implications", which presents the outcomes summary and practical implications.

2. Materials and Methods

The data for the selected variables have been obtained from the World Bank, and the variables selected are the carbon dioxide emissions (CO_2), a more highly educated labor force (EL), the GDP per capita (GDP), and the research and development expenditures (RD). The CO_2 is measured in kilotons, the EL is a percentage of the total working force with advanced education, the GDP is measured as per capita constant with the 2010 US dollar, and RD is the research and development expenditure as a percentage of GDP. The panel data range from 1995 to 2020 for the MINT countries.

In accordance with Karakul [28], we have decided to use the following specification for our CO_2 emissions model:

$$CO_{2,it} = \alpha_0 + \alpha_1 EL_{it} + \alpha_2 GDP_{it} + \alpha_3 RD_{it} + u_{it} \quad (1)$$

where EL represents highly educated labor and is added as a crucial element of environmental quality. Ref. [34] has argued that human capital will lower the consumption of energy and has concluded that a greater level of human capital leads to lowering filthy energy consumption, hence boosting the use of environmentally friendly energy. Studies have indicated that firms with higher human capital more potentially implement strategies of cleaner manufacturing and disclose greater conformity with the environment; consequently, human capital negatively affects CO_2 emissions. The controlled variables include the GDP per capita and the research and development. Equation (1) is modified to an error-correction modeling framework to get the short-run results. The modified equation is as:

$$\begin{aligned}\Delta CO_{2,it} = \pi + \sum_{p=1}^{n1} \pi_{1p} \Delta CO_{2,it-p} + \sum_{p=0}^{n2} \pi_{2p} \Delta EL_{it-p} + \sum_{p=0}^{n3} \pi_{3p} \Delta GDP_{it-p} + \sum_{p=0}^{n4} \pi_{4p} \Delta RD_{it-p} + \beta_1 CO_{2,it-1} \\ + \beta_2 EL_{it-1} + \beta_3 GDP_{it-1} + \beta_4 RD_{it-1} + u_t\end{aligned} \quad (2)$$

where Δ will give short-term impacts and $\beta_2 - \beta_5$ estimates normalized on β_1 will give the long-term effects. Pesaran and Shin [35] developed the panel ARDL-PMG approach, which has become the workhorse of time-series analysis. Moreover, Pesaran and Shin [36] propose the ECM or t-test and F test for the significance of the validity of long-run coefficient estimations. The study has broadened the empirical literature in order to investigate asymmetry analysis. Shin and Yu [37] have been the first to introduce the change to linear modeling. Using the idea of the partial sum, EL is decomposed into two new time series as follows:

$$\sum_{n=1}^{t} \Delta EL_{it}^{+} = \sum_{n=1}^{t} \max\left(\Delta EL_{it}^{+}, 0\right) \quad (3a)$$

$$\sum_{n=1}^{t} \Delta EL_{it}^{-} = \sum_{n=1}^{t} \min\left(\Delta EL_{it}^{-}, 0\right) \quad (3b)$$

where EL_{it}^{+} represents the partial sum of positive shocks, and EL_{it}^{-} represents the portion sum of adverse shocks to the labor force with a higher level of education. The two decomposed time series EL_{it}^{+} and EL_{it}^{-} are substituted to EL_{it} in Equation (2) to obtain:

$$\begin{aligned}\Delta CO_{2,it} = \pi + \sum_{p=1}^{n1} \pi_{1p} \Delta CO_{2,it-p} + \sum_{p=0}^{n2} \pi_{2p} \Delta EL_{it-p}^{+} + \sum_{p=0}^{n3} \pi_{3p} \Delta EL_{it-p}^{-} + \sum_{p=0}^{n4} \pi_{4p} \Delta GDP_{it-p} + \sum_{p=0}^{n5} \pi_{5p} \Delta RD_{it-p} \\ + \beta_1 CO_{2,it-1} + \beta_2 EL_{it-1}^{+} + \beta_3 EL_{it-1}^{-} + \beta_4 GDP_{it-1} + \beta_5 RD_{it-1} + u_t\end{aligned} \quad (4)$$

Equation (2) is a symmetric or linear ARDL-PMG model, where Equation (4) is an asymmetric or nonlinear ARDL-PMG model. Shin and Yu [37] have utilized the identical estimating procedure and diagnostic tests. In the asymmetric model, the normal ARDL diagnostic tests are also employed. The study further employs the Wald test to test the asymmetry. Lastly, the asymmetric causality between the aforementioned variables is evaluated using Hatemi-j [38] panel asymmetric causality tests.

3. Results and Discussion

The first step of the empirical investigation is to check the dataset for the unit root problem. For this purpose, the study employs three different types of tests, including ADF-Fisher [39], Pesaran and Shin IPS test [40], and Levin, Lu, and Chin (LLC) [41].

The results of the aforementioned tests are depicted in Table 1, indicating that only GDP is stationary at a level, and CO_2, EL, RD are stationary at the first difference, and none of the variables are stationary at the 2nd difference. These results demonstrate that

we are able to use ARDL-PMG since the variables are mixed stationary at a level and first difference. The Akaike information criterion (AIC) is used to determine the appropriate lag length and the findings lead the researchers to the conclusion that there should be no more than two lags.

Table 1. Panel unit root test.

Series	LLC		IPS		ADF	
	Level	**1st Diff.**	**Level**	**1st Diff.**	**Level**	**1st Diff.**
CO_2	−0.591	−6.361 [a]	−0.766	−4.386 [a]	1.739	−6.816 [a]
EL	0.807	−5.401 [a]	−2.109	−4.027 [a]	−2.042 [b]	-
GDP	−5.747 [a]	-	−2.313 [b]	-	−1.973 [b]	-
RD	−2.148 [c]	-	−1.608	−3.873 [a]	−0.239	−5.674 [a]

Note: [a], [b], [c] show statistical significance at 1%, 5%, and 10%, respectively.

The results of the symmetric and asymmetric models, together with the results of additional diagnostic tests, are detailed in Table 2. The cointegration tests, such as the ECM(-1) and Kao tests, are the most important diagnostic tests, as they test the presence of cointegration relationships among the variables. The results of the aforementioned tests confirm the presence of cointegration for the variables, such as CO_2, EL (EL positive (EL+), EL negative (EL−)), GDP, and RD. Following the conclusion of our deliberation over the cointegration, we will proceed to discuss the outcomes of the symmetric and asymmetric models.

In Table 2, the result of the ARDL-PMG concluded that the coefficient of EL is negative and significant in the linear model, hence it has a substantial negative impact on CO_2 emissions, which suggests that a one percent increase in the proportion of the labor force with higher levels of education results in a 1.99 percent decrease in CO_2 emissions. These findings are consistent with those found earlier [17,42]. People may have increased responsibility with regard to environmental laws and rules if they get an education, which can raise their level of knowledge about the environment and its adverse effects, as well as boost their awareness of the environment [13,28]. This understanding may also permeate the educated managers, owners, and workers of businesses, who may be more environmentally conscious. Knowledge is a crucial instrument for achieving sustainable growth, and economic expansion is a fuel for carbon dioxide emissions [21,22].

Additionally, a labor force that is educated or competent improves the overall effectiveness of the manufacturing process, which in turn implies significantly reduced energy usage, hence causing carbon dioxide emissions to fall. Additionally, a highly educated worker may assist in manufacturing creative and environmentally friendly goods, which has the potential to result in lower levels of carbon dioxide emissions. This is another way that a workforce that is more educated may help bring about a decrease in the emissions of carbon dioxide. According to the results of the asymmetric or nonlinear analysis, the EL+ coefficient is negative and significant, which shows that a one percent increase in the educated workforce can result in a 2.74 percent reduction in carbon dioxide emissions. Similarly, the calculated EL− coefficient is negatively significant, which verifies that a decrease in the educated workforce would result in an increase in carbon dioxide emissions. The coefficient of the variable shows that a decrease of one percent in the educated workforce results in an increase of 5.40 percent in carbon dioxide emissions. The asymmetric findings provide further support for the symmetric findings by demonstrating that a positive shock in the highly educated workers is associated with an improvement in environmental quality. In contrast, a negative shock in the highly educated workers is associated with a deterioration in environmental quality.

Table 2. Results of ARDL-PMG and NARDL-PMG.

ARDL-PMG				
Variable	**Coefficient**	**Std. Error**	**t-Stat**	**Prob**
		Long-run		
EL	−1.994 **	0.984	1.872	0.043
GDP	0.064 *	0.038	1.548	0.091
RD	−1.602 ***	0.439	3.366	0.001
		Short-run		
D(EL)	−0.713	0.562	1.171	0.194
D(EL(−1))	−1.636	1.868	0.809	0.355
D(GDP)	−0.026 ***	0.008	2.977	0.001
D(GDP(−1))	−0.012	0.024	0.493	0.549
D(RD)	0.166	0.244	0.626	0.462
D(RD(−1))	−0.111	0.159	0.647	0.449
C	−3.205 ***	0.954	3.100	0.001
		Diagnostics		
Log-likelihood	180.734			
ECM(−1)	−0.131 ***	0.038	3.088	0.001
Kao-cointegration test	4.024 ***			
NARDL-PMG				
		Long-run		
EL+	−2.747 ***	0.924	2.748	0.004
EL−	−5.406 ***	2.577	1.939	0.038
GDP	0.062 *	0.036	1.570	0.090
RD	−0.801	0.496	1.491	0.105
		Short-run		
D(EL+)	−3.223 *	1.934	1.539	0.092
D(EL+(−1))	−5.547 **	2.188	2.342	0.013
D(EL−)	−0.723	0.758	0.881	0.319
D(EL-(−1))	0.501	2.045	0.226	0.746
D(GDP)	−0.031 **	0.012	2.358	0.012
D(GDP(−1))	−0.015	0.019	0.754	0.387
D(RD)	0.182	0.269	0.621	0.465
D(RD(−1))	−0.071	0.124	0.525	0.528
C	−0.807	1.305	0.571	0.498
		Diagnostics		
Log-likelihood	189.1			
ECM(−1)	−0.312 ***	0.121	2.398	0.001
Kao-cointegration test	4.957 ***			
Wald-LR	5.226 ***			
Wald-SR	1.859			

*, ** and *** show significant level of 1%, 5%, and 10% respectively.

An increase in the proportion of the workforce that possesses a high level of education has led to the conservation of traditional energy sources and a reduction in carbon dioxide emissions. This indicates that an improvement in the proportion the of educated workforce leads to a reduction in the energy/educated labor ratios in the environmentally friendly economy, which ultimately results in less carbon dioxide being released into the atmosphere. The highly educated workforce is experiencing a negative shock that is boosting energy consumption and deteriorating environmental quality. Furthermore, the ratio of energy to highly educated labor has increased due to a decline in the number of educated workers, which has ultimately led to an increase in carbon dioxide emissions.

Gao and Ding [43] have concluded that a highly educated labor force plays a substantial role in the process of developing an environmentally friendly economy, and this finding has our full endorsement. Education has a more pronounced impact on environmentally conscious economics, namely through the enhancement of manufacturing efficiencies. The participation of women in the labor market is more crucial than previously thought, in the transition to household consumption of renewable energy globally [18]. The educated

workforce is also having an effect on the quality of the environment. Concerning the long-term asymmetric impacts of an educated workforce with the positive and negative shocks on carbon dioxide emissions, the magnitude difference between the positive and negative estimates is highly evident, as supported by the statistically significant WALD-LR results. This difference in size can be attributed to the fact that the long-run asymmetric effects are expected to have a greater impact on carbon dioxide emissions. A one percent increase in the GDP results in a 0.064 percent increase in the carbon dioxide emissions in the linear analysis, and a 0.062 percent increase in the carbon dioxide emissions in the nonlinear analysis. The GDP coefficient is significantly positive in both models, making it one of the control variables with a significantly positive value. This finding suggests that the increased economic growth in the MINT economies is responsible for increases in carbon dioxide emissions. The MINT economies' reliance on non-renewable energy sources, which are the main producers of carbon dioxide and the main engines of economic expansion, maybe a possible explanation for this phenomenon [8,32,44]. In a similar vein, the predicted coefficient of research and development is significantly negative in the linear model, but not at all significant in the nonlinear model. This means that a one percent increase in RD will result in a 1.734 percent reduction in carbon dioxide emissions in the linear model. The quality of the environment may be improved in many different ways by RD, for example, by adding novel and energy-efficient techniques of manufacturing, altering people's purchasing behavior from energy-intensive to energy-saving, and encouraging cleaner and greener energy sources. Additionally, each of these pursuits contributes to the overall decrease in carbon dioxide emissions, which is an essential component in the battle against global warming [45].

In the short term, the outcomes of linear & non-linear models are shown in Table 3, which also demonstrates those results. The coefficient of D(GDP) becomes significant, while the other variables become negligible in the short term in the linear model. This is because D(GDP) is the variable that best predicts GDP. Similarly, the coefficients of D(EL) and D(GDP) are significant in the nonlinear model, but the estimated coefficients of all the other variables are negligible. The short-run asymmetry impacts between D(EL+) and D(EL−), on the other hand, are validated with large WALD-SR estimates as well.

Table 3. Panel symmetric and asymmetric causality.

Null Hypothesis:			W-Stat	Zbar-Stat	Prob
Symmetric Causality					
EL	causes	CO_2	8.50	5.06	0.00
CO_2	causes	EL	3.89	1.45	0.09
GDP	causes	CO_2	1.38	−0.52	0.51
CO_2	causes	GDP	3.61	1.22	0.16
RD	causes	CO_2	4.08	1.60	0.07
CO_2	causes	RD	3.23	0.92	0.28
GDP	causes	EL	1.68	−0.28	0.69
EL	causes	GDP	3.00	0.74	0.38
RD	causes	EL	1.69	−0.28	0.69
EL	causes	RD	4.74	2.11	0.02
RD	causes	GDP	4.23	1.71	0.05
GDP	causes	RD	3.01	0.76	0.37
Asymmetric Causality					
EL+	causes	CO_2	1.97	−0.07	0.85
CO_2	causes	EL+	3.92	1.43	0.10
EL-	causes	CO_2	6.22	3.21	0.00
CO_2	causes	EL−	5.77	2.86	0.00
GDP	causes	CO_2	1.38	−0.52	0.51
CO_2	causes	GDP	3.61	1.22	0.16
RD	causes	CO_2	4.08	1.60	0.07
CO_2	causes	RD	3.23	0.92	0.28

Table 3. *Cont.*

Null Hypothesis:			W-Stat	Zbar-Stat	Prob
EL-	causes	EL+	8.54	5.00	0.00
EL+	causes	EL−	5.54	2.68	0.00
GDP	causes	EL+	1.31	−0.58	0.48
EL+	causes	GDP	5.46	2.62	0.00
RD	causes	EL+	1.83	−0.18	0.77
EL+	causes	RD	2.53	0.36	0.63
GDP	causes	EL−	0.93	−0.87	0.31
EL-	causes	GDP	3.07	0.78	0.36
RD	causes	EL−	1.16	−0.69	0.41
EL-	causes	RD	5.15	2.38	0.01
RD	causes	GDP	4.23	1.71	0.05
GDP	causes	RD	3.01	0.76	0.37

The findings of both the linear and nonlinear tests of causality are shown in Table 3. We did not uncover any evidence that there was a causal relationship between the majority of the factors. It is clear from looking at Table 3 that the linear model only includes unidirectional chains of causation extending from EL to CO_2 and EL to RD. On the other hand, in the nonlinear model, we find significantly greater evidence of unidirectional causation, as well as bi-directional causality between EL- and CO_2.

4. Conclusions and Policy Implications

Using both the ARDL-PMG and the NARDL-PMG methodologies, the purpose of this research has been to investigate the effect that highly educated workers have on the administration of green economies in the MINT nations throughout the period of time between 1995 and 2020. The results of the ARDL-PMG demonstrate that in the long term a highly educated labor force negatively affects carbon emissions. These findings reveal that carbon dioxide will be significantly reduced when industries start hiring a highly educated workforce, which in turn will result in an improvement in environmental quality. Similarly, the results of the analysis of the NARDL long-term PMG demonstrate that a positive shock in an educated workforce leads to a reduction in environmental pollution. In contrast, a negative shock in an educated workforce leads to increased pollution emissions in the MINT economies. These conclusions were drawn from the analysis of the relationship between labor force education and pollution emissions. The MINT economies are often favored in the sector and use the most recent environmentally friendly technology in their manufacturing facilities and industrial settings. The most recent technologies can reduce energy use while also improving environmental conditions. The outcomes of the short-term results also concluded that an educated workforce with a positive shock cuts pollution emissions, which confirms the popularity of the green revolution. However, it is shown in the results of a long-run analysis that it will have a favorable impact on the economy. The findings of the NARDL-PMG study indicate, moreover, that a rise in GDP is associated with an increase in carbon emissions, but RD is not associated with a substantial influence on carbon emissions.

The following recommendations for public policy can be made in light of the findings of this study. The empirical findings shed light on the significance of recognizing the need to make investments in the education of the workforce, since doing so leads to the reduction in the consumption of traditional energy sources. Therefore, it is vital to take the proper actions to increase the abilities of the labor force by educating them to increase the usage of appliances that are more energy efficient. This is necessary to boost the green economy. Increasing education will unquestionably assist in increasing innovation and the development of the abilities of the workforce, which will pave the route towards environmentally friendly economic growth. There is still a significant amount of room for improvement and modification in the skilled labor force that is present in the MINT countries. The recommendation for public policy is that the policymakers of the

MINT nations should focus on promoting their educational structure and reducing regional imbalances. This can be accomplished by concentrating on elementary, secondary, and high school education, as well as post-secondary education. This will serve as fresh impetus for fostering a more synchronized and expedited environmentally responsible expansion of the economy. In addition, in order to improve the structure of the manufacturing sector, it is necessary to eliminate any restrictions that stand in the way of the expansion of the educational system. In order to improve the effectiveness of environmentally friendly production, the rates of workforce engagement among educated women should be raised. The agricultural, industrial, and service sectors should be given more opportunities to learn about environmental issues from their respective governments. In the green economy, the authorities should also work to lower the ratio of educated laborers to energy workers. The attention of the legislators should be focused on environmentally friendly businesses as well as the conservation of ecosystems. Similar to Jardim and Bártolo [46], the study also recommends the promotion of a worldwide entrepreneurial culture by disseminating programs on entrepreneurial skills via international educational networks. These competencies will facilitate the transmission of knowledge to society on a worldwide scale, since they contribute to the resolution of issues, such as unemployment and poverty, the environment and sustainability, health, and quality of life.

5. Limitation and Further Research

As it investigates the influence that educated workers have on the successful management of green development, this study encounters very few restrictions. In further research, it may also be possible to take into account additional aspects, such as greenhouse gases, air quality indicators, and ecological footprints, to quantify green growth and the quality of the surrounding environment. It is possible that future studies will build on their analysis of the connection between highly educated workers and green development for additional areas and nations other than the MINT economies, by using a variety of statistical tools and econometric approaches. Research in these areas will undoubtedly help to build a better understanding of the connection between an educated workforce and the management of green growth, resulting in the formulation of environmentally friendly growth strategies that are more sustainable.

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