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LEVEL OF EDUCATION AND RENEWABLE ENERGY CONSUMPTION NEXUS IN SAUDI ARABIA

Haider Mahmood
Associate Professor, Department of Finance, College of Business Administration, Prince Sattam bin Abdulaziz University, 173 Alkharj 11942, Saudi Arabia.
Email: haidermahmood@hotmail.com

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Abstract

Purpose: A level of education may change the energy consumption habits of people. Further, economic growth may also demand cleaner energy consumption for better environmental quality. This research explores the impacts of education and economic growth on the renewable energy consumption of Saudi Arabia.

Methodology: This research utilizes the unit root test of Dickey & Fuller (1981), cointegration test of Pesaran et al. (2001), and bound testing values of Kripfganz & Schneider (2020).

Main Findings: Income and secondary education increase Renewable Energy Consumption (REC) in the long and short run. Primary education reduces REC in the long run, and the lag of primary education has a positive effect on REC.

Implication: This research recommends to increase the level of education to promote renewable energy consumption for a cleaner environment.

Novelty: Educational level and renewable energy consumption nexus have not been investigated in Saudi Arabia. Therefore, we claim an empirical contribution.

Keywords: *Level of Education, Economic Growth, Renewable Energy Consumption, Cointegration.*

INTRODUCTION

The target of sustainable development is to target every developed and emerging economies in this modern era of the world for the demand for a cleaner environment. The environment is only possible if countries shift their energy profile towards cleaner sources. Therefore, renewable and clean Energy Consumption (EC) is pivotal for any sustainable growth of the country. The use of cleaner energy is mainly demanded due to the environmental awareness of the inhabitance of any country and this awareness is stem from the educational attainment and human capital development. In this debate, Balaguer & Cantavella (2018) argued that the development of new energy resources also depends on the Human Capital (HC) and education process and content of the country. Education may increase the awareness of clean use of energy which may also significantly reduced the pollution consequently. In this domain, we can't ignore the role of economic development as well because education and growth are complementary phenomena that grow hand by hand and pursue the demand for a cleaner environment as well. Therefore, a tight environmental policy might not be needed to pursue because education tames the people for the use of pollution energy consumption which is also because of growth and demand a higher standard of living.

Yao et al. (2019) connected the level of education with energy consumption. They found that higher education and human capital helped to reduce 17% of fossil fuel energy and promote the 86% more cleaner energy in the OECD countries. Further, improving human capital helped in reducing 17% of overall energy consumption. So, developing human capital is found helpful in improving energy efficiency and also reduced the need for dirty energy consumption by replacing it with renewable sources. Therefore, it was suggested to invest in educational activities to mend the energy consumption profile of the country. Constant (2019) argued another dimension of human capital and environment that weak environmental policies could lead to human capital inequalities. Because weak policies are affecting the economic growth and human capital because of unequal treatment to each segment of society. If human capital, particularly education, is delivered equally to society, then, the environment would also improve because of a better level of awareness in society.

In another dimension, Alkhateeb & Mahmood (2019) discussed the role of trade on energy consumption. Trade and growth are also complementary which upsurge the EC but a type of energy, cleaner or dirty, dependents on the level of development and pattern of trade as well. Also, Mahmood et al. (2019) corroborated a significant effect of trade on pollution emissions. In this connection, a seminal study by Grossman & Krueger (1991) argued that the type of energy use is depending on the level of development. At an earlier stage, dirty energy consumption may be ignored to gain some level of growth. Later, this phenomenon would not work due to a higher level of development, education, and standard of living. Later, cleaner energy technologies would be demanded by society in the second development stage of the country. Hence, the level of growth and education handsomely contribute to the cleaner type of energy.

In the case of Saudi Arabia, Omri et al. (2019) explored a dimension of HC with the environmental profile of the country. They also probed the role of investment, income, and financial markets and found their positive effects on the pollution emissions of the country. However, they could not validate the statistical relationship in human capital and emissions. This can be claimed due to a reason that human capital affects energy consumption and its type at first and then it could have an effect on the emission on the second stage. Secondly, human capital carries other social and economic indicators along with education. Hence, the most important out of which is education which may change the mindset of society and motivate for cleaner energy use. Consequently, the environment may improve due to energy-efficient techniques of educated labor and entrepreneurs or the trend of energy consumption may shift toward cleaner and renewable sources energy replacing dirty technologies and fossil fuel consumption. But, Saudi literature is silent to this important aspect of the relationship between education and REC in Saudi Arabia.

Hence, we are highly motivated to explore this relationship considering the economic growth side by side using a maximum time range of targeted variables for the economy of Saudi Arabia.

LITERATURE REVIEW

The EC and environment nexus are well explored in the literature. For an instant, Mahmood et al. (2018) explored EC and pollution emission nexus in Saudi Arabia and found a positive association. Further, income and financial development were also found responsible for pollution emission in the Kingdom. Mahmood et al. (2019) reconnoitred energy intensity and pollution emissions in East Asia. They found that energy intensity was increasing the pollution emissions in the local and neighbouring economies through spillover effects. Further, the effects of trade and foreign investment were also found positive on the emissions.

In the human capital and education aspects, Yong et al. (2019) investigated a study and found that HC helped in managing the green human resources in the firms. So, this green human resource would help in adopting cleaner production techniques in the firms. Shields (2019) explored another dimension of education and the environment. He found that student mobility at the international level was found responsible for higher pollution emissions at a global level. Chen & Fang (2018) investigated the interconnection of energy and HC in China. At first, the energy usage improves the economic activities and growth of the country. In the second stage, economic growth enabled the country to invest in education and human and physical capital. In turn, education could help to generate energy-saving technologies which would help in reducing energy consumption or change the type of energy towards the cleaner's sources.

Zafar et al. (2019) enquired about the linkages of HC and pollution in the USA. They argued that energy use accelerates economic activities and growth which could affect the pollution in response. In empirical exercise, they found a 2-way relationship between human capital and pollution. Pollution was also carried a 2-way relationship with other investigated variables i.e. income growth and energy use. It means that increasing human capital may enable efficient use of energy resources and could help to reduce pollution consequently. Bano et al. (2018) investigated HC and emissions nexus. Generally, it is a perception that protecting the environment in a developing country needs some scarification of economic growth. The authors argued that pollution could be controlled without reducing the economic activities in the country if human capital is rightly invested in the country to educate the realization of pollution. Overall, the authors found that HC was found helpful in reducing pollution in Pakistan.

Taylor et al. (2007) investigated education and stormwater pollution. They argued that the education campaign might play a very important role in enhancing awareness among people about the pollution. They connected the educational campaigns and stormwater pollution and found that educational campaigns found helpful to reduce stormwater pollution. This study realized the importance of an educational campaign for cleaner energy consumption as well. Qudrat-Ullah & Kayal (2018) argued that developing an interactive environment to educate the people for a clean environment could help to awareness of a clean environment in the society. Because an interactive environment can eliminate the barriers in the way of learning and can help reduce pollution emissions at the macro level. Hence, the micro-level effort of interactive learning could enhance the macro-environmental performance of the country through valid educational policies.

Ponce et al. (2019) explored the multi-facet association between labor, human capital, and the energy sector. They argued that increasing the income of labor would help to change the energy and environment sector of the country. In the same way, education may also shape and train the labor for energy efficiency which may reduce energy consumption and may protect the environment. On the other hand, poor educational policies could neglect the awareness of clean energy consumption and environmental effects as well. Hence, good educational policies could change the behavior toward energy efficiency for a campaign of decreasing EC and to support the cleaner environment. Ma et al. (2019) investigated and corroborated a U-shaped connection between HC and the environment. At a lower level of education and human capital, people were not supporting the environmental policies and at a higher level of education, environmental policies were supported. So, human capital reduced ecological footprints and investment in the education sector and human capital could have pleasant environmental effects.

Bekaroo et al. (2019) argued that environmental awareness can be channelized through educational institutions in any country. In this process, teachers could play an active role in spreading awareness to conserve energy resources and to reduce pollution. They argued that higher education institutions are better sources to disseminate information on environmentally friendly technologies and awareness. They collected primary data on this issue form a large size sample from higher education institutions of Mauritius and found that environmental policies through higher education were the most effective way to channelize the awareness which could control the pollution in the country.

Mahmood & Furqan (2020) investigated the spatial effects of oil rents and income on pollution emissions in the GCC region. They originated a non-linear relationship in oil rents and emissions and income and emissions. Moreover, Saudi Arabia was found in the first phase. Hence, increasing income and oil rents carried environmental consequences. Moreover, the spillover effects of both variables showed that increasing growth and oil rents also affected the neighboring countries' environment. Al-Mulali & Tang (2013) probed the impact of macroeconomic variables on pollution emissions in GCC countries. They found that income and energy use has accelerated the pollution in the GCC and foreign investment helped to reduce it. Bekhet et al. (2017) explored the factors of EC and emissions in GCC countries. They found the causality from emissions to EC in three GCC countries and from the financial market to pollution emissions in other three GCC countries

In a particular case of Saudi Arabia, Omri et al. (2019) explored human capital and the environment but could not validate the statistical relationship. Mahmood et al. (2019) scrutinized the role of agriculture in pollution. They established a positive effect of income growth and a negative asymmetrical impact of agriculture on pollution emissions. Alkhtalan & Javed (2013) probed the emissions and electricity relationships in Saudi Arabia. They found that gas and oil-based electricity increased emissions. Mahmood et al. (2020) explored the effects of urbanization and industry on pollution emissions and found the positive effects of both variables. Additionally, the authors found the asymmetry in the relationship between industry and emissions.

Literature signifies the role of education and HC on EC and the environment. It is observed from the literature that education may improve awareness in people to use cleaner energy and to care about the environment. In the case of Saudi Arabia, Omri et al. (2019) investigated but could not establish a significant relationship between HC and pollution. Still, a gap is existing in the literature to explore the effect of level of education on REC. Hence, this present research is the target to investigate this relationship.

THEORETICAL FRAMEWORK

A seminal study of Grossman & Krueger (1991) validated an inverted U-shaped association between income and emissions. The basic logic behind this relationship is that economic growth increases EC and pollution at first. At a later stage, a clean environment is the demand of society hence helps to reduce the emissions. There is a need to cover the linkage of a cleaner environment with economic growth in the second stage. Growth increases energy demand to fuel the increasing economic activities. If the environment gets cleaner at the second stage, then cleaner technologies or cleaner source energies are required to achieve a cleaner environment. Hence, the role of education for the awareness of cleaner sources cannot be ignored here. Secondly, education is required at a higher level to developed cleaner technologies for production. Hence, education is pertinent to utilize cleaner energy in both cases. Empirical literature also supports this phenomenon that human capital is found helpful to improve the environment without reducing growth and also encourage cleaner sources and discourage fossil fuel energy consumption (Bano et al., 2018).

Education is a long process that needs a long time to have significant effects on society. Hence, education could ensure long-run sustainable growth. To achieve the mission in the right way, it is needed to increase the awareness in society to awake the responsibility of society for a cleaner environment (Ergen & Ergen, 2011; Jankal & Jankalova, 2017). In another channel of this relationship, Balaguer and Cantavella (2018) claimed that education may increase the income of people which may demand a cleaner environment and also increase social awareness. Zafar et al. (2019) claimed that education would help to develop energy-efficient technologies that encourage cleaner energy and discourage fossil fuel sources. Hence, education and human capital development may reduce pollution levels.

METHODOLOGY

The theoretical and empirical literature signifies that economic growth, education, and human capital could have significant effects on the environment and pattern of EC. Yao et al. (2019) advocated the role of human capital on EC which carries educational indicators and some other indicators as well. Therefore, this research targets to test the effects of different levels of education on renewable energy consumption. For this purpose, the present study relies on the secondary data available at the Government of Saudi Arabia (2020) and the World Bank (2020). This research utilizes primary and secondary education because these levels of education may help to discipline the personalities who can contribute to environmentally friendly technologies and awareness. Our hypothesized model is as follows:

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$$RE_t = f(GDP_t, PRI_t, SEC_t) \quad (1)$$

RE_t is a renewable energy consumption percentage of Gross Domestic Product (GDP), PRI_t is primary enrolments and SEC_t is secondary enrollments. PRI_t and SEC_t are proxies for educational levels. GDP_t is in Saudi Riyals and is a proxy for economic growth. All series are taken from 1971-2018 and utilized in natural logarithm form. PRI_t and SEC_t are taken from the Government of Saudi Arabia (2020). RE_t and GDP_t are taken from World Bank (2020) and missing data of RE_t are completed from BP energy statistics. The time series might have unit root so it is tested with the Augmented Dickey-Fuller test (ADF) of Dickey & Fuller (1981) in the following way:

$$\Delta x_t = \delta x_{t-1} + \sum_{i=1}^{n} \beta_i \Delta x_{t-i} + \omega_{1t} \quad (2)$$

$$\Delta x_t = \alpha_0 + \delta x_{t-1} + \sum_{i=1}^{n} \beta_i \Delta x_{t-i} + \omega_{2t} \quad (3)$$

$$\Delta x_t = \alpha_0 + \alpha_1 t + \delta x_{t-1} + \sum_{i=1}^{n} \lambda_i \Delta x_{t-i} + \omega_{3t} \quad (4)$$

Equation 2 may be tested with H_0 of unit root and its rejection is evidence of stationary series. Equations 3 and 4 are tested as same as equation 2. After these analyses, the Auto-Regressive Distributive Lag (ARDL) of Pesaran et al. (2001) is utilized to estimate the long and short-run relationships as follows:

$$\Delta RE_t = \gamma_0 + \gamma_1 RE_{t-1} + \gamma_2 GDP_{t-1} + \gamma_3 PRI_{t-1} + \gamma_4 SEC_{t-1} + \sum_{j=1}^{p} \gamma_{5j} \Delta RE_{t-j} + \sum_{j=0}^{q} \gamma_{6j} \Delta GDP_{t-j} + \sum_{j=0}^{r} \gamma_{7j} \Delta PRI_{t-j} + \sum_{j=0}^{p} \gamma_{8j} \Delta SEC_{t-j} + \psi_t \quad (5)$$

H_0: $\gamma_1 = \gamma_2 = \gamma_3 = \gamma_4 = 0$ no-cointegration will be tested to verify cointegration through a bound test. The bound test utilizes the statistics of Kripfganz & Schneider (2020). The diagnostic tests will also be employed to validate the ARDL model's efficiency. Then, the error correction term (ECT_{t-1}) will be added in equation 5 for short-run analysis in the following way:

$$\Delta RE_t = \pi ECT_{t-1} + \sum_{j=1}^{p} \gamma_{5j} \Delta RE_{t-j} + \sum_{j=0}^{q} \gamma_{6j} \Delta GDP_{t-j} + \sum_{j=0}^{r} \gamma_{7j} \Delta PRI_{t-j} + \sum_{j=0}^{p} \gamma_{8j} \Delta SEC_{t-j} + \psi_t \quad (6)$$

Negative π would settle a short-run relationship. The rest estimated coefficients can be elaborated for short-run effects.

DATA ANALYSES AND DISCUSSIONS

Table 1 shows the ADF test analysis with intercept (C) and trend (T). RE_t and PRI_t have a unit root at a level and are stationary after first differences. SEC_t with C analysis is stationary and GDP_t is stationary in C and C&T analyses. However, SEC_t and GDP_t are stationary after the first difference. Hence, a mix of order is corroborated but ARDL cointegration is efficient in this case due to the bound testing (Pesaran et al., 2001).

Table 1: ADF Test

Variable	C	C&T	None
RE_t	-2.1295 (0.2361)	-2.4929 (0.3301)	-0.9173 (0.3139)
GDP_t	-2.6505 (0.0906)*	-3.9373 (0.0182)**	2.0083 (0.9882)
PRI_t	-2.5240 (0.1165)	-1.3463 (0.8627)	1.1371 (0.9317)
SEC_t	-4.1070 (0.0023)***	-1.1324 (0.9121)	0.3193 (0.7736)
ΔRE_t	-7.6990 (0.0000)***	-7.7080 (0.0000)***	-7.7670 (0.0000)***
ΔGDP_t	-5.0520 (0.0001)***	-5.2201 (0.0005)***	-4.4226 (0.0000)***
ΔPRI_t	-6.0893 (0.0000)***	-6.3597 (0.0000)***	-5.9723 (0.0000)***
ΔSEC_t	-10.1788(0.0000)***	-10.0613(0.0000)***	-10.0170 (0.0000)***

Note: *,** and *** indicate no-unit root at 10%, 5% and 1% level, respectively.

Source: Author's Calculations

Table 2 carries the results of ARDL and the bound test shows that F-value is quite low and even lower than the upper critical F-value of Kripfganz & Schneider (2020) at 10%. So, the bound test could not verify cointegration. Hence, it is corroborated with an alternative way suggested by Pesaran et al. (2001) as per the negative parameter of ECT_{t-1}. Moreover, the diagnostic tests also validated the efficiency of results as all p-values are more than 0.1.

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Table 2: ARDL Estimates

Variables	Parameter	S.E.	*t*-value	*p*-value
Long Run				
GDP_t	1.2335	0.7082	1.7417	0.0892
PRI_t	-5.3707	1.6708	-3.2145	0.0026
SEC_t	2.9287	1.2571	2.3297	0.0250
Short Run				
ΔGDP_t	0.4447	0.2626	1.6934	0.0982
ΔPRI_t	-4.1323	9.9888	-0.4137	0.6813
ΔPRI_{t-1}	18.8261	10.4501	1.8015	0.0792
ΔSEC_t	1.0559	0.4957	2.1299	0.0394
ECT_{t-1}	-0.3605	0.1127	-3.1998	0.0027
Diagnostics				
Bound Test	Calculated F-value = 2.7905		Critical Bound F-values At 1% (3.2778-4.3109) At 5% (2.5448-3.4712) At 10% (2.2001-3.0679)	
F-Hetro	1.1831			0.3353
F-Serial	0.0358			0.9649
F-RESET	0.0127			0.9110
χ^2*-Normality*	2.5415			0.2215

Source: Author's Calculations

The GDP_t has a positive effect on RE_t and estimated elasticity is more than 1 in the long run. So, increasing income has a pleasant effect on consuming renewable energy in the Kingdom. Further, the response of the use of renewable energy is more than 1%, with a 1% increase in income. It shows that level of development of a country is demanding cleaner energy consumption for a cleaner environment. PRI_t reduces the use of renewable energy with high elasticity. It corroborates that a lower level of education is a hurdle in the way of cleaner use of energy. 1% increasing PRI_t is reducing 5.37% of RE_t. SEC_t promotes REC with high elasticity. So, a secondary level of education is found helpful in raising awareness of using renewable energy. Moreover, a 1% increasing SEC_t is increasing 2.93% of renewable energy. These results show the significance of the higher level of education for the use of REC and a higher level of education is extremely important for a cleaner environment as a primary education carries a negative and secondary education that carries a pleasant effect for the use of renewable energy. The negative effect of primary education and the positive effect of secondary education realize the U-shaped relationship as a lower level of education is reducing renewable energy consumption and a higher level of education is improving it. This result is matched with Ma et al. (2019). Yao et al. (2019) also corroborated that increasing human capital is reducing EC in the country. Moreover, empirical literature also indirectly supports our results as some studies corroborated the positive role of education in reducing pollution levels (Balaguer & Cantavella, 2018; Zafar et al., 2019; Bano et al., 2018).

In the short run, GDP_t may increase RE_t with an estimated inelastic effect. So, increasing growth has a pleasant effect on consuming renewable energy in the Kingdom. A 1% increase in income has 0.44% use of renewable energy. PRI_t has an insignificant effect on the REC but its lag has a positive effect. It corroborates that the primary level of education carries a pleasant effect on REC with a lag effect. SEC_t increases the use of REC with high elasticity, like a long-run effect. A secondary level of education is also found helpful in the short-run in raising awareness of using renewable energy. A 1% increasing SEC_t is increasing 1.06% of renewable energy. Hence, education is also found helpful in promoting REC.

CONCLUSIONS

Education is a process that may change the thinking style of people in favor of renewable energy consumption to support the cleaner environment. This research investigated the effect of growth and educational levels on the use of renewable energy consumption of Saudi Arabia using the period 1971-2018 and the ARDL cointegration technique. The cointegration is found for a hypothesized model. The long and short runs' effects are found positive on renewable energy consumption. Hence, growth has pleasant effects in encouraging renewable energy use in the Kingdom. Primary education plays a negative role in reducing REC. However, its lag has a positive effect on REC. Secondary education has a positive effect on promoting REC in the long run. Our results corroborate the importance of education level in promoting cleaner energy as primary education is discouraging and secondary education is promoting the REC.

SUGGESTIONS

Based on the results, the present research recommends improving the level of education of inhabitance to encourage the usage of renewable and cleaner energy consumption. The results confirm that the secondary has pleasant effects on the REC. Hence, the government should focus on the secondary enrollments and its completion rate to support the REC in the Kingdom of Saudi Arabia. Moreover, economic growth is found helpful in promoting REC. Hence, the growth-enhancing strategies would also promote the REC and cleaner environment in the Kingdom.

LIMITATION AND STUDY FORWARD

The present study has investigated the role of the level of education on the REC. Hence, literature has utilized and signified the importance of using human capital or human development indices. But, the present study could not utilize such indicators due to the non-availability of data. Future studies can extend this work by developing the proxy for such indicators and may contribute to the literature by investigating the REC and human development nexus in Saudi Arabia.

AUTHORS CONTRIBUTION

Haider Mahmood is the single author of this publication. He did the empirical and theoretical literature review and established the hypothesis. Then, he tested the hypothesis of the nexus between renewable energy consumption and level of education in the Kingdom of Saudi Arabia and completed all sections of this paper.

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