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Education, Financial Development, and Primary Energy Consumption: An Empirical Analysis for BRICS Economies

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Abstract: Energy is life blood of all economies and an indispensable prerequisite for all economic activities and consequently factors influencing the energy consumption are of vital importance. Therefore, this study investigates the effect of education together with financial development on energy consumption in sample of BRICS economies over the 1990–2019 period by means of second-generation cointegration and causality analyses thanks to the small number of empirical studies. The causality analysis unveils a one-way causal effect from education to primary energy consumption, but an insignificant causality between financial development and primary energy consumption. The cointegration analysis uncovers a strong positive effect of education at panel level and in all BRICS economies in the long-term, but financial sector development has a significant positive influence on primary energy use only in South Africa in the long-term. The findings of the study reveal that education considerably increases the primary energy use in the BRICS economies through economic growth channel, but financial sector development has not been a significant determinant of primary energy use yet. However, the BRICS economies should attach more importance to green technology and energy focused growth for sustainable growth and development.

Keywords: education; financial development; primary energy use; panel causality analysis; panel cointegration analysis

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1. Introduction

Energy is a prerequisite for almost all economic activities of production and consumption. Therefore, all countries at different stages of economic development need the energy to keep their economies grow. The world energy use has also been raised substantially in line with the considerable increases in global economic growth and population as of Industrial revolution and the world energy consumption is anticipated to go up about 50% during the 2018–2050 [1]. However, world energy requirement has been largely met from the primary energy types such as oil, coal, natural gas, and wind energy. The share of oil, coal, natural gas, and renewables in total primary energy use in 2020 was 31.2%, 27.2%, 24.7%, and 5.7% respectively [2]. The dependency on non-renewables seems to continue in the near future despite the intensive struggles for development of renewables.

The specification of factors underlying primary energy use are important for sustainable economic growth and development given high dependence on non-renewables. Therefore, factors underlying energy consumption have been widely investigated in the related literature and economic growth, GDP per capita, investment, financial development, urbanization, globalization, trade openness, foreign direct investments have been found to significant determinants of energy consumption [3–6]. However, the effect of education, also a significant factor for economic growth in the context of endogenous growth theories, on energy consumption has been relatively little explored. Therefore, this paper is focused on the influence of education together with financial development on primary energy consumption given the gap in the empirical literature.

Education can influence the energy use through several channels. First, education can raise the energy consumption by fostering the economic growth. Secondly, education is expected to make the production and technology more efficient and can reduce the energy consumption depending on development levels of the countries, because the developed countries try to decrease the energy consumption for environmental sustainability [7]. Thirdly, education can decrease the energy consumption by raising the environmental awareness of the individuals and direct them to use green energy sources and energy efficient devices [7]. The net effect of education on energy use varies based on which effects outweigh.

Financial sector development, as a determinant of economic growth, can also foster the energy use through economic growth. Financial sector development may also increase the energy consumption by procuring the funds for purchases of goods such as cars, refrigerators, and houses etc. [8,9]. On the contrary, financial sector development can decrease the energy consumption by procuring the funds to the firms for development of technologies and products with relatively higher energy efficiency [10]. Furthermore, financial development can provide individuals and firms with the hedging opportunities against for energy price fluctuations. As a result, the net effect of financial sector development on energy consumption can be theoretically varied based on which effects outweigh. Lastly, energy use can also influence financial development by fostering the demand towards financial products through buy and use of durables and houses [11].

The objective of the study is to explore the influence of education and financial sector development on primary energy use in the BRICS economies, drivers of global economic growth and development. This study purposes to make a contribution to the related literature in three ways. The nexus of education and energy use has been relatively little explored in the empirical literature. In this context, only a few searchers (e.g., see [7,12]) have analyzed the interplay between education and energy consumption and some scholars (e.g., see [13–16]) have investigated the effect of education on renewable energy use. Therefore, this article targets to make a contribution to the related literature by analyzing the nexus. Secondly, this study is one of the first studies to analyze the interaction between education and primary energy use in sample of BRICS economies, significant drivers of the global economy. Thirdly, employment of second generation cointegration and causality tests and AMG (augmented mean group) estimator leads us to acquire relatively more robust findings. In the remaining particle of the article, the empirical studies about the interaction among education, financial development, and primary energy use is summarized in Section 2; Section 3 explains the variables and method; Section 4 performs the econometric applications and argues the findings within the scope of related literature and the paper is concluded with Section 5.

2. Literature Review

The global economy and population have significantly increased as of Industrial revolution, but also environmental problems and considerable decreases in natural resources have accompanied the economic and population growth. Therefore, the United Nations has pioneered the efforts to protect the environment and natural resources at the international level as of 1970s. In this context, the 17 Sustainable Development Goals (SDGs) launched by the United Nations in 2015 is a universal call to protect the world, end poverty and ensure that all people enjoy peace and prosperity by 2030 and quality education, affordable and clean energy, clean water and sanitation, sustainable cities and communities, climate action, life on land and life below water are among the 17 SDGs [17].

Energy is a significant factor underlying sustainable development. Therefore, determinants of primary energy and renewable are important for achievement of sustainable development goals. The factors influencing the energy use have been commonly investigated in the literature, but the influence of economic growth, GDP per capita, investment, financial development, urbanization, globalization, trade openness, foreign direct investments on energy use have been generally investigated [3–6]. On the other hand, economic growth, real GDP, sectoral composition, financial development, human capital, urban population, intellectual property rights, trade liberalization, CO_2 emissions, and non-renewable energy prices, have been documented as the drivers of renewable energy consumption [18–22].

The influence of education on energy consumption have relatively little explored in the empirical literature. Therefore, the influence of education together with financial development on primary energy use is investigated in this study. Only a few searchers have analyzed the interplay between education and energy consumption and discovered a one-way causal effect from education to energy consumption [7,12]. In this context, Inglesi-Lotz and Morales [7] analyzed the interaction between primary energy use and secondary education enrolment in 11 developing and 10 developed countries over the 1980–2013 term by Granger causality test and reached a one-way causal effect from education to primary energy use. In another study, Rej and Nag [12] also investigated the nexus between energy consumption and educational attainment proxied by education index in India over the 1990–2016 term via Johansen-Juselius cointegration test and discovered a unidirectional causal effect from education to energy use. In addition to this, some studies have examined the nexus between education and renewable energy use and found out a positive effect of education on renewable energy consumption [13–16].

Furthermore, some studies have examined the mutual nexus between energy consumption and human development in the empirical literature, but have found out mixed findings. In this context, Ouedraogo [23] analyzed the nexus between energy use and human development in 15 developing economies for the 1988–2008 term through causality and cointegration analyses and revealed insignificant short-term relationship between two variables, but a negative relationship between energy use and human development in the long term. However, Rej and Nag [24] uncovered a one-way causal effect from human development to energy consumption in India for the 1990–2016 period via vector error correction model. On the other hand, Lekana and Ikiemi [25] revealed a positive influence of energy use on human development in economies of the Economic and Monetary Community of Central Africa over the 1990–2019 period through regression analysis. Some studies have also investigated the nexus between renewables and human development and discovered a two-way causal interplay between renewables and human development [26–28].

The finance-energy nexus has been investigated by relatively more researchers, but mixed findings have been revealed based on countries' economic development levels, research methods and study period in harmony with the theoretical expectations. Most of the studies displayed in Table 1 such as Kakar et al. [29], Bekhet et al. [30], Kahouli [31], Mukhtarov et al. [32], Ma and Fu [33], Aslan et al. [34], and Godil et al. [35] have found a positive effect of financial sector development on energy consumption. On the other hand, relatively few studies such as Chtioui [36], Chang [37], Ozdeser et al. [38] have revealed a negative effect of financial sector development on energy consumption. An insignificant relationship between two variables was revealed by Topcu and Payne [39] and Denisova [40]. Furthermore, some researchers have examined the causal interplay between energy consumption and financial development, but have revealed different causality between two variables. A one-way causal effect from energy use to financial development for Asian economies was discovered by Furuoka [41], a one-way causal effect from financial development for Turkey was disclosed by Çağlar and Kubar [42] and Ayaydın et al. [43] and a two-way causal interplay between two series for Pakistan was reached by Shahbaz et al. [44] and a one-way causal effect from financial sector development to primary energy use for EU transition members was revealed by Bayar et al. [45].

Table 1. Literature summary about finance-energy use nexus.

Study	Country, Study Period	Method	Influence of Financial Sector Development on Energy Use
Sadorsky [11]	Central and Eastern European countries	Regression approach	Positive
Kakar et al. [29]	Pakistan, 1980–2009	Time series analysis	Positive
Bekhet et al. [30]	Gulf Cooperation Council economies, 1980–2019	Simultaneous equation model	Positive
Kahouli [31]	South Mediterranean economies, 1995–2015	ARDL and VECM approach	Positive
Mukhtarov et al. [32]	Kazakhstan, 1993–2014	Vector error correction model	Positive
Ma and Fu [33]	120 countries, 1991–2014	Regression approach	Positive in developing countries; insignificant impact in developed countries
Aslan et al. [34]	G7 economies and emerging economies, 1990–2015	VAR approach	Stock market development had a positive impact in both group countries, but banking sector had a positive impact in emerging economies and negative in G7 economies
Godil et al. [35]	India, 1995–2018	ARDL approach	Positive
Chtioui [36]	Tunisia, 1972–2010	Cointegration and VECM	Negative
Chang [37]	53 countries	Regression approach	Negative
Ozdeser et al. [38]	Nigeria, 1960–2019	ARDL approach	Negative
Topcu and Payne [39]	32 high income countries, 1990–2014	Regression approach	Insignificant interaction
Denisova [40]	Germany, 1990–2018	Regression approach	Insignificant interaction
Bayar et al. [45]	EU transition economies, 1996–2017	Cointegration and causality analysis	Positive
Xu [46]	China, 1999–2009	Regression approach	Positive
Shahbaz and Lean [47]	Tunisia, 1971–2008	Time series analysis	Positive and bilateral causality
Islam et al. [48]	Malaysia, 1971–2009	Vector error correction model	Positive
Al-mulali and Lee [49]	Gulf Cooperation Council economies, 1980–2019	Pedroni cointegration test	Positive
Mahalik et al. [50]	Saudi Arabia, 1971–2011	ARDL approach	Positive
Mukhtarov et al. [51]	Azerbaijan, 1992–2015	Johansen Cointegration	Positive
Janpolat et al. [52]	32 Belt and Road countries, 2000–2015	Pedroni and Kao cointegration test	Positive

To sum up, there have been studies investigating the interaction between human capital, human development, primary and renewable energy consumption in the empirical literature as seen in the literature summary, but only Inglesi-Lotz and Morales [7] and Rej and Nag [12] directly analyzed the interaction between education and energy use in the related literature. Therefore, this article aims to make a contribution to the empirical literature taking notice of the research gap, sample and employment of second-generation econometric tests.

3. Data and Research Method

The paper investigates the effect of education together with financial development on primary energy use considering the significant effect of education on human capital, technological development, innovation, and entrepreneurship (e.g., see Pegkas and Tsamadias [53] and Maneejuk and Yamaka [54]). The variable of primary energy consumption (ENERGY) is substituted with primary energy as gigajoule per capita. On the other hand, education (EDU) is represented by education index of UNDP (United Nations Development Programme) [55] and financial development (FD) is substituted with annual financial development index by IMF [56]. The financial development index is produced taking the access, efficiency, and depth of financial institutions and markets into consideration and gets values between 0–1 (higher value indicates more developed financial system) (see Svirydzenka [57] for the index methodology). The data of primary energy consumption per capita, education, and financial sector development is respectively procured from BP [2], UNDP [55], and IMF [56]. All variables are yearly and study term is 1990–2019, because the variable of education existed for all countries in the sample for 1990–2019 period.

The sample of the research is formed from 5 BRICS (Brazil, Russia, India, China, and South Africa). The statistical software packages of EViews 11.0, Gauss 12.0, and Stata 15.0 were employed for the econometric applications.

The main econometric model for panel AMG estimation is as following:

$$y_{it} = \beta_i x_{it} + u_{it} \quad (1)$$

where y is the dependent variable of primary energy (ENERGY) and x includes the independent variables of education level (EDU) and financial development (FD) and β_i is the country-specific slope on the dependent variable. Lastly, u consists of the unobservables and the error terms.

The research hypotheses are as follows:

Hypothesis (1). *There is a relationship between education level and primary energy consumption.*

Hypothesis (2). *There is a relationship between financial sector development and primary energy consumption.*

The descriptive characteristics of the dataset are displayed in Table 2. The mean of primary energy use, education index, and financial development index are respectively 100.189 gigajoule per capita, 0.5915, and 0.455. However, especially primary energy use considerably changes among the BRICS economies, but education index and financial development index are relatively stable among the BRICS economies.

Table 2. Descriptive characteristics for series.

Characteristic	Observations	ENERGY	EDU	FD
Mean	150	100.189	0.5915	0.455
Maximum	150	244.970	0.823	0.657
Minimum	150	9.434	0.127	0.191
Standard Deviation	150	78.779	0.592	0.111

In the econometric analysis, the cointegration relationship between education, financial development, and primary energy use is investigated through Westerlund and Edgerton [58] bootstrap cointegration taking heterogeneity and cross-sectional dependency into consideration unlike the first-generation cointegration tests. Furthermore, the causality between education, financial development, and primary energy use is analyzed by Dumitrescu and Hurlin [59] causality test takes notice of heterogeneity and produces the efficient results under cross-sectional independence unlike the traditional Granger causality test. Lastly, the AMG estimator also takes notice of heterogeneity and cross-sectional dependence and produces the robust estimations in case of endogeneity problem resulting from error term.

In the application part of the article, econometric tests of cross-sectional independence, homogeneity, and stationarity were performed and thereafter, cointegration analysis was implemented. Cross-sectional dependence hypothesizes that countries in a sample are not affected by shocks in a country in sample. Any shock in a country may quite likely influence the other countries of the sample in diverse ways thanks to the ongoing high economic, social, political, and cultural globalization. Hence, panel-data econometric models mainly have substantial cross-section dependence [60]. In the study, the availability of cross-sectional dependence was investigated by means of LM (Lagrange multiplies), LM CD (cross-section dependence), and $LM_{adj.}$ (bias-adjusted LM test) tests, respectively, by Breusch and Pagan [61], Pesaran [62], and Pesaran et al. [63]. On the other hand, the subsistence of homogeneity was investigated with delta tilde tests by Pesaran and Yamagata [64].

The subsistence of unit root in the variable is investigated by CIPS (Cross-Sectionally augmented IPS (Im-Pesaran-Shin [65]) unit root test by Pesaran [66] due to the subsistence of cross-sectional dependence. In the unit root test, the CADF (Cross-sectional Augmented Dickey Fuller) test statistics are firstly calculated for all cross-sections, and then the CIPS test statistics are calculated through taking the arithmetic averages of the CADF statistics. The CADF test statistics are calculated as follows:

$$t(N,T) = \frac{\Delta y_i' \overline{M}_i y_{i-1}}{\overline{\sigma}^2 \left(\Delta y_{i-1}' \overline{M}_i y_{i-1}\right)^{1/2}} \tag{2}$$

where $\overline{M} = (\tau, \Delta\overline{y}, \overline{y}_{t-1})$, $\tau = (1,1,\ldots,1)'$, $\Delta\overline{y} = (\Delta\overline{y}_1, \Delta\overline{y}_2, \ldots, \Delta\overline{y}_t)'$, $\overline{y}_{t-1} = (\overline{y}_0, \overline{y}_1, \ldots, \overline{y}_{t-1})'$ and $\overline{\sigma}^2 = \frac{\Delta y_i' \overline{M}_{i,w} \Delta y_i}{T-4}$.

The CIPS test statistics are calculated by the following equation:

$$CIPS = N^{-1} \sum_{i=1}^{N} t(N,T) \tag{3}$$

A significant cointegration relationship among two or more non-stationary time or panel data series indicate that non-trivial linear combination of the series is stationary [67] and the cointegration test is necessary to check whether the variables under consideration share a common trend consisting of a long term relationship [68]. The cointegration nexus among education, financial development, and primary energy use is analyzed by Westerlund and Edgerton [58] bootstrap cointegration which takes heterogeneity, cross-sectional dependency, heteroscedasticity, and autocorrelation into consideration and produces relatively more robust results for small sample sizes [58]. The critical values, generated from the bootstrapping process, instead of asymptotic probability values from standard normal distribution are based on if there exists cross-sectional dependency [58].

Westerlund and Edgerton [58] cointegration test follows the lagrange multiplier (LM) process of McCoskey ve Kao [69] and scalar variable of y_{it} is generated by following Equation (4):

$$y_{it} = \alpha_i + x_{it}\beta_i + z_{it} \tag{4}$$

where t (time dimension) = 1, ... , T and i (cross-section dimension) = 1, ... , N. $z_{it}(error\ term) = u_{it} + v_{it}$ and $v_{it} = \sum_{j=1}^{t} \eta_{ij}$ (η_{ij} represents the error term with independent normal distribution, zero mean and variance of σ_i^i). The hypotheses of the cointegration test are as follows:

$H_0 = \sigma_i^2 = 0$ (There exists significant cointegration among the series for all cross-sections).
$H_1 = \sigma_i^2 > 0$ (There exists insignificant cointegration among the series for some cross-sections).

Westerlund and Edgerton [58] cointegration test calculates the LM test statistic through Equation (5):

$$LM_N^+ = \frac{1}{NT^2} \sum_{i=1}^{N} \sum_{t=1}^{T} \hat{\omega}_i^{-2} S_{it}^2 \tag{5}$$

where S_{it} indicates the partial sum of z_{it} and $\hat{\omega}_i^{-2}$ denotes the long-term variance of u_{it}.

The cointegration coefficients are calculated with AMG estimator by Eberhardt and Teal [70] taking cross-sectional dependence, and heterogeneity into consideration and the estimator generates panel and country level cointegration coefficients. The AMG estimator takes notice of common factor and dynamic effects in the variables and generates efficient estimation for unbalanced panels and can be employed in case of endogeneity problem resulting from error term [71]. The AMG estimator is formed by adding common dynamic effect to each cross-section regression to calculate the cross-sectional dependency:

$$y_{it} = \beta_i' x_{it} + u_{it} \tag{6}$$

$$u_{it} = \alpha_i + \lambda_i' f_t + \varepsilon_{it} \tag{7}$$

where λ_i' is factor loadings and f_t is unobservable factor.

The AMG estimator is produced from a two-stage process. In the first stage, first-differencing of the variables of is taken and $\mathrm{T} - 1$ time dummies (D_t) are added to the model and the model is estimated through a FD-OLS regression.

$$\Delta y_{it} = b_i' x_{it} + \sum_{t=2}^{T} c_t \Delta D_t + e_{it} \rightarrow \hat{c}_t \equiv \hat{u}_t \tag{8}$$

In the second stage, $\hat{u}_t$ is included in Equation (6) and in turn Equation (9) is obtained by adding to each of N standard country regressions:

$$y_{it} = \alpha_i + \beta_i' x_{it} + c_i t + d_i \hat{u}_t + e_{it} \tag{9}$$

$$\hat{b}_{AMG} = N^{-1} \sum_i \hat{b}_i \tag{10}$$

Last, the causal interplay among education, financial development, and primary energy use is investigated by Dumitrescu and Hurlin [59] causality test. The causality analysis originally developed by Granger [72] indicates whether a variable gives useful information in estimation of future values of another variable [73]. Holtz-Eakin et al. [74] employs the causality analysis for panel data models and tests the null hypothesis of absence of homogeneous Granger causality versus alternative hypothesis of homogeneous Granger causality. However, Dumitrescu and Hurlin [59] improves the causality analysis to test the absence of a homogeneous Granger causality relationship under the null hypothesis against the alternative hypothesis that this relationship exists in at least one cross-section.

Dumitrescu and Hurlin [59] causality test takes notice of the following linear heterogenous model in Equation (11) for each cross-section in case X and Y represent the stationary process for N cross-sections during T period:

$$y_{i,t} = \alpha_i + \sum_{k=1}^{K} \gamma_i^{(k)} y_{i,t-k} + \sum_{k=1}^{K} \beta_i^{(k)} x_{i,t-k} + \varepsilon_{i,t} \tag{11}$$

where $\beta_i = \left(B_i^{(1)}, B_i^{(2)}, B_i^{(3)} \ldots, B_i^{(K)}\right)$. The individual effects (α_i) are assumed to be constant and lag parameters $\left(\gamma_i^{(k)}\right)$ and regression slope coefficients $\left(\beta_i^{(k)}\right)$ are postulated to varies among the cross-sections. The lag length (K) is assumed to be constant for the cross-sections. The null and alternative hypotheses tested from Equation (11) are as following:

$$H_0 = \beta_i = 0 \; \forall i = 1, \ldots, N$$

$$0 \leq \frac{N_1}{N} < 1 \tag{12}$$

$$H_0 = \beta_i = 0 \; \forall i = 1, \ldots, N_1$$

$$= \beta_i \neq 0 \; \forall i = N_1 + 1, \ldots, N$$

4. Empirical Analysis

In the econometric section of the research, econometric tests of cross-sectional dependence and heterogeneity to set the suitable tests of cointegration and unit root are implemented. The subsistence of cross-sectional dependence is explored by LM, LM CD, and $LM_{adj.}$ tests, and the tests' results are reported in Table 3. The null hypothesis of cross-sectional independence is denied, and the availability of cross-sectional dependence is thus revealed. The availability of homogeneity is investigated by delta tilde and adjusted delta tilde tests and two tests' results are reported in Table 3. The null hypothesis of homogeneity is denied, and the absence of homogeneity is thus found.

Table 3. Cross-sectional dependence and heterogeneity tests' results.

Test	Test Statistic	Probability Value
LM	37.69	0.000
LM CD *	2.695	0.0070
LM_{adj} *	17.55	0.000
$\widetilde{\Delta}$	20.718	0.000
$\widetilde{\Delta}_{adj.}$	22.255	0.000

* two-sided test.

The subsistence of unit root in the ENERGY, EDU, and FD is investigated by the CIPS unit root test due to the subsistence of cross-sectional dependence, and the test findings are reported in Table 4. The null hypothesis (there exists unit root in the series) of the unit root test is accepted for three variables at their level values, because the CIPS test statistics are found to be lower than the critical values. But, the CIPS test statistics are found to be higher than the critical values for the unit root analysis with the first-differenced values of the variables, and in turn null hypothesis is declined and three series are found to be I(1).

Table 4. CIPS test results.

Variables	Constant	Constant + Trend
ENERGY	−1.959	−2.062
D(ENERGY)	−3.164 ***	−3.475 ***
EDU	−1.975	−1.670
D(EDU)	−3.681 ***	−3.644 ***
FD	−1.901	−2.261
D(FD)	−4.718 ***	−4.705 ***

*** It is significant at 1% significance level.

The cointegration nexus among education, financial development, and primary energy use is investigated by means of Westerlund and Edgerton [58] cointegration test thanks to presence of cross-section dependency and heterogeneity between the variables and the test findings are depicted in Table 5. The probability values based on bootstrapping process is found to be higher than 5% and in turn presence of significant cointegration relationship among education, financial development, and primary energy use is concluded.

Table 5. Bootstrap cointegration test results.

Constant			Constant + Trend		
Test Statistic	Asymptotic p-Value	Bootstrap p-Value	Test Statistic	Asymptotic p-Value	Bootstrap p-Value
0.130	0.048	0.940	1.979	0.024	0.818

Note: The critical values based on bootstrapping are produced from 10,000 repetitions.

The slope coefficients are predicted by AMG estimator and estimated coefficients were reported in Table 6. The panel coefficients demonstrate that educational attainment had a significant positive effect on primary energy consumption in the long-term. On the other hand, country level coefficients denote that educational attainment have a positive influence on primary energy consumption in all BRICS economies, but financial sector development raised the primary energy consumption only in South Africa.

Table 6. Estimation results of cointegration coefficients.

Countries	EDU	FD
Brazil	0.970 ***	0.185
China	2.685 ***	0.204
India	3.607 ***	0.012
Russian Federation	1.835 **	0.309
South Africa	2.999 ***	0.849 **
Panel	1.685 *	0.230

***, **, * respectively denotes that it is significant at 1%, 5% and 10% significance level.

Educational attainment can differently influence the primary energy use via diverse channels. A positive effect of education on primary energy use is expected through economic growth channel and a negative effect of education on primary energy use is expected through development of green technologies, energy efficient technologies, and improvements in environmental awareness. However, a strong positive effect of educational attainment on primary energy use in the BRICS economies is revealed and the positive effect of education on primary energy use is found to be relatively higher in India, South Africa, and China. India, China, and Brazil have respectively achieved the largest progress in education during the study period as seen in Table 7. Therefore, the higher effect of education on primary energy use can be resulted from the nexus of education-economic growth.

Table 7. Evolution of education in the BRICS economies.

Countries	Year	Education Index	Change (%)
Brazil	1990	0.463	
	2019	0.694	49.89
China	1990	0.405	
	2019	0.657	62.22
India	1990	0.311	
	2019	0.555	78.45
Russia	1990	0.663	
	2019	0.823	24.13
South Africa	1990	0.532	
	2019	0.724	36.09

Source: UNDP [55].

On the other hand, the effect of education on primary energy use is found to be relatively lower in Brazil although Brazil has experienced a significant progress in education. This contradiction is probably resulted from relatively higher renewable energy share in total final energy consumption, because the share of renewable energy use in total final energy consumption in Brazil, China, India, Russia, and South Africa in 2018 is respectively 47.06%, 13.12%, 31.68%, 3.18%, and 10.34% [75]. Our findings indicate economic growth channel dominates the other channels in the impact of education on primary energy use.

The findings are also consistent with findings of Inglesi-Lotz and Morales [7] and Rej and Nag [12], because Inglesi-Lotz and Morales [7] reveals a causality from education to energy consumption, but higher education level increases the energy consumption in the developing countries and decreases the energy consumption in the developed countries. On the other hand, a significant effect of education on energy consumption in the long run in an emerging market of India is disclosed by Rej and Nag [12]. Furthermore, the researchers investigating the interaction between human development and energy consumption or renewable energy consumption have reached mixed findings based on development levels of the countries [23–28]. Furthermore, the positive influence of education on primary energy consumption also points out that BRICS economies have not reached the technological level and environmental awareness of the developed countries to decrease the primary energy use.

Financial development has potential to affect the primary energy use through various channels such economic growth, stimulation of demand towards durables and other devices consuming energy, and increases the investments in energy efficient technologies, and renewables. The BRICS economies have experienced considerable improvement in financial development as presented in Table 8, but a significant positive influence of financial development on primary energy use is obtained only for South Africa and financial development has an insignificant influence on primary energy use at panel level and in other BRICS economies.

Table 8. Evolution of financial system in the BRICS economies.

Countries	Year	Financial Development Index	Change (%)
Brazil	1990	0.2080	
	2019	0.6574	216.07
China	1990	0.2784	
	2019	0.6301	126.33
India	1990	0.2044	
	2019	0.4298	110.31
Russia	1990	0.3707	
	2019	0.4806	29.62
South Africa	1990	0.3249	
	2019	0.6418	97.57

Source: IMF [56].

The empirical literature on the nexus of finance-energy in Table 1 have mainly revealed mixed findings. However, the findings are found to be inconsistent with the most of the related literature, but to be consistent with only Topcu and Payne [39] and Denisova [40]. This contradiction can be resulted from that financial system has not reached the threshold level to foster energy consumption.

The causality among education, financial development, and primary energy consumption is examined via Dumitrescu and Hurlin [59] causality test, and test findings are reported in Table 9. The causality analysis unveils a one-way significant causality from educational attainment to primary energy consumption. The causality analysis also indicates that financial sector development has an insignificant influence on primary energy use in the short term.

Table 9. Results of causality test.

Null Hypothesis:	W-Stat.	Zbar-Stat.	Prob.
D(EDU) $\nrightarrow$ D(ENERGY)	2.56001	2.00439	0.0450
D(ENERGY) $\nrightarrow$ D(EDU)	1.14712	0.08186	0.9348
D(FD) $\nrightarrow$ D(ENERGY)	0.43807	−0.88294	0.3773
D(ENERGY) $\nrightarrow$ D(FD)	1.03835	−0.06614	0.9473

The findings of causality analysis between education and energy consumption are disclosed to be consistent with the limited literature of Inglesi-Lotz and Morales [7] and Rej and Nag [12]. But the findings of causality analysis between finance and energy are inconsistent with the related literature, because different significant interaction between financial development and energy consumption has been disclosed [41–45].

5. Conclusions

Energy is an essential factor for almost economic activities such as consumption and production. Furthermore, world energy requirement has been procured from non-renewables for a long time and the trend is not anticipated to change in the next a few decades. Therefore, identification the factors underlying primary energy use is critical for right policy making by public and private representatives. Therefore, the influence of education together with financial development on primary energy consumption is investigated by means of causality and cointegration tests regarding the gap in the empirical literature.

In the econometric analysis, a significant one-way causality running from education to primary energy consumption is unveiled. The causality analysis indicates that education has significant influence on primary energy use in the short-term, but financial sector development does not have a significant influence on primary energy use in the short run. The findings of causality analysis between education and energy consumption are consistent with Inglesi-Lotz and Morales [7] and Rej and Nag [12], but the findings between finance and energy are mainly inconsistent with the related literature [41–45].

Then, a significant cointegration interaction among education, financial sector development, and primary energy consumption is revealed and then cointegration coefficients are estimated. The panel cointegration coefficients disclose that education has a positive influence on primary energy use in the long run, but financial sector development does not have a significant influence on primary energy use. On the other hand, country level coefficients denote that education has a strong positive influence on primary energy consumption in the long-term mainly through economic growth channel. The findings about the nexus between education and energy are consistent with findings of Inglesi-Lotz and Morales [7] and Rej and Nag [12]. On the other hand, financial sector also has a positive influence on primary energy use in all BRICS economies, but it is significant only in South Africa and the findings are inconsistent with the most of the empirical literature, but consistent with only Topcu and Payne [39] and Denisova [40].

Our findings indicate that education has a significant influence on primary energy use in short and long-term and the interplay between education and energy is mainly resulted from the economic growth channel, but, financial sector development has not had a significant influence on primary energy use in short and long-term yet. However, education and financial sector development have potential to decrease the primary energy use especially through making a contribution to development of energy efficient technologies, renewables, and environmental awareness over time. Therefore, the BRICS economies make benefit of education together with environmental awareness programs to decrease the positive effect of education on primary energy use. Furthermore, educational policies should be designed to improve the green technologies and energy. Future studies can be focused on the role of education in the interaction between technological development and energy consumption.

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