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RESEARCH ARTICLE

Causal Relationship between Energy Consumption, Economic Growth, and Financial Development: Evidence from South Asian Countries

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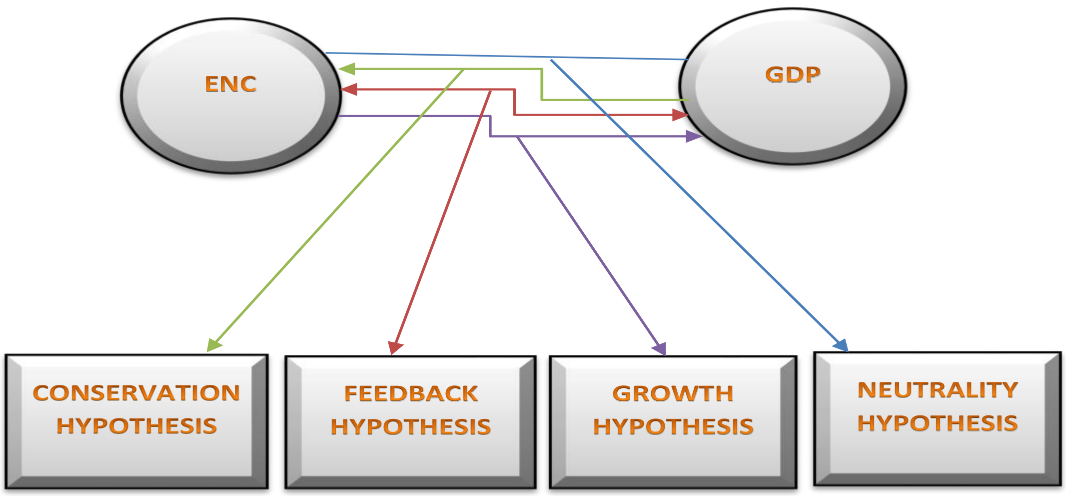
Abstract
Energy is a challenging and emerging problem in the world. Most South Asian countries have limited means but they cannot utilize a major part of their resources due to the high cost of exploration. However, few countries in this region have sufficient capacity and abundant energy resources to overcome the issues related to energy, but due to several reasons, they are not going to play an effective role in this field. As we know South Asian economies have limited resources and facing energy crises due to these reasons, we conduct research on this region as well. The aim of this study is to examine the relationship between economic growth (GDP), financial development (FD), and energy consumption (ENC) for South Asian countries for the period 1991-2020. For the empirical purpose, panel co-integration approaches are applied. However, the Pooled Mean Group (PMG) long-run result shows that the impact of financial development (FD) and economic growth (GDP) on energy consumption (ENC) is positive and significant. Based on the Vector Error Correction Methodology (VECM) Granger causality results, Conservation Hypothesis holds between the economic growth (GDP) and energy consumption (ENC) in the South Asian Region both in the short-run as well as in the long run. Moreover, the results also indicate that two-way causality exists between financial development (FD) and energy consumption.

Keywords: Energy Consumption; Financial Development; Economic Growth; Conservation Hypothesis; ARDL; VECM

Introduction

The energy sector is probably the biggest global industry after the financial sector with the widest effect on almost all other sectors of the economy since all the economic activities depend on energy both in the rural as well as in urban areas. For the functioning of the economy, energy accessibility is considered a prerequisite and it also affects the production cost of the commodities. Energy is also considered the important foundation for the development and growth of an economy because energy is used for multi-purposes in different sectors. Hypotheses related to the direction of the causality between ENC and the GDP can be expressed as economic growth is to be considered the evolution of GDP in the long, medium, and short terms. The causal relationship between GDP and ENC has been characterized by four different hypotheses (Acaravci & Ozturk, 2010; Apergis & Payne, 2010a, 2010c). Scale effect and method effect are both positively and adversely associated with energy usage, according to Shahbaz, Sinha, and Kontoleon (2022) energy consumption is increased by the composition impact and economic globalisation. On the other hand, energy usage falls as a result of financial progress and rising oil prices.

First, “Growth Hypothesis” when causality association running from ENC towards GDP, in this situation the dependence of the country’s economy on energy is too high that shocks in the energy supply lead to a negative impact on the growing process of the economy, additionally, in this case, energy saving-oriented strategies may have a harmful effect on the GDP (Masih & Masih, 1998). Second, the “Conservation Hypothesis” is valid only in one situation when a one-way causal association runs from the GDP towards ENC, in this case, there is less use of energy, then there will be no negative effect of energy-saving policies on the GDP (Jumbe, 2004). The third one is the “Feedback Hypothesis” which indicates the two-way causality association between GDP and ENC. In this scenario, a decrease/increase in the use of energy leads to a decrease/increase in the GDP and vice versa. The last, one is the “Neutrality-Hypothesis” which discusses that both GDP and the ENC do not affect each other, in other words, there is no causality among the variables (Yu & Choi, 1985).



Fig#1

Energy is a challenging and emerging problem in the world. Most South Asian countries have limited means but they cannot utilize a major part of their resources due to the high cost of exploration. However, few countries in this region have sufficient capacity and abundant energy resources to overcome the issues related to energy, but due to different reasons, unfortunately, they are not going to play an efficient role in this field. i.e. Pakistan is not politically stable and has not had enough funding to resolve this issue. Environmental issues are increasing day by day due to the inefficient use of energy e.g., increasing the level of pollution. For the standard life of citizens, a clean and friendly environment is a necessity. Researchers are working on the issue of how to make efficient use of energy and achieve the requirements. As we know South Asian economies have limited resources and facing energy crises due to these reasons, we conduct research on this region as well. Hence, the present study is an attempt to add to the present literature in such a way. First, we have made some modifications in the model as compared to the previous studies as we take some additional variables (industrialization, urbanization, foreign direct investment, trade, and energy prices) in our model. In the existing literature, none of the studies has checked the association of ENC with FD, GDP, IND, URB, FDI, trade, and energy prices in the same model. Furthermore, unlike the previous studies which focus on a single country we examine the impact of the FD and GDP on ENC for the South Asian region by using the Panel Autoregressive distributed lag (ARDL) model and the VECM Granger causality technique. We also examine which hypothesis exists among these four hypotheses i.e., the Conservation Hypothesis, the Growth Hypothesis, the Feedback Hypothesis, and the Neutrality Hypothesis in the case of the South Asian region which contribute in the literature. The rest of the study is formed in a manner that part two is related to the review of the literature, section three is related to estimation methods, and the model, Section four shows the result's discussion as well as conclusions.

Literature

In previous literature, many studies examined the association between ENC and GDP from both prospectives empirically and theoretically, see (Altunbas & Kapusuzoglu, 2011; Apergis & Payne, 2010b, 2011; Apergis & Tang, 2013; Bartleet & Gounder, 2010; Belloumi, 2009; Chontanawat, Hunt, & Pierse, 2008; Huang, Hwang, & Yang, 2008; Narayan, Narayan, & Prasad, 2008; Narayan & Smyth, 2008; Ozturk & Acaravci, 2013; Ozturk, Aslan, & Kalyoncu, 2010; Saatçi & Dumrul, 2013; Sari & Soytas, 2007; Stern, 1993; Tang & La Croix, 1993; Yu & Choi, 1985). Similarly, these studies (Ciarreta & Zarraga, 2010; Menegaki, 2011; Pirlogea & Cicea, 2012) have also checked the association between ENC and GDP but in the case of EU countries. While some studies have shown the important role of the ENC on GDP in recent years (Al-Yousif, 2002; Feng, Sun, & Zhang, 2009; Kar, Nazlıoğlu, & Ağır, 2011; Masten, Coricelli, & Masten, 2008). Furthermore, Yu and Choi (1985) examine the association between ENC and GDP and used the granger causality test. While, Stern (1993) examines the association between ENC and GDP by using the vector autoregressive model; Kivyiro and Arminen (2014) check the association between CO_2 emissions, ENC, GDP, and FDI by using the panel ARDL approach for Sub-Sahara Africa; Fuinhas and Marques (2013) also use the ARDL bound testing methodology to check the association between ENC and the GDP; Yoo (2006) implied Grange causality and Co-integration test for Malaysia; Chen, Kuo, and Chen (2007) also used the Co-integration and the

Granger test for Malaysia. In previous years, the causality association between ENC and GDP has got the attention (Bekhet, Matar, & Yasmin, 2017; Omri, 2013; Omri & Chaibi, 2014; Omri & Kahouli, 2014; Saidi & Hammami, 2015; Shahbaz, Bhattacharya, & Mahalik, 2018; Shahbaz & Lean, 2012). On the other hand, in various studies unidirectional causality exists, i.e. Stern and Cleveland (2004) identified that the one-way causality association that is running from the ENC to the GDP while, an opposite view is that causality is running from GDP to the ENC (Simson, Sharma, & Aziz, 2011). Altunbas and Kapusuzoglu (2011) examine the association between ENC and GDP. The finding shows a one-direction causal relationship, running from the GDP towards ENC, and has found that there is no co-integration between the gross domestic product (GDP) and the ENC. Likewise, some studies have also argued on the basis of empirical results, that there is no long-term connection between the ENC and the GDP**.** In their study, Apergis and Payne (2009) investigated the connection between ENC and GDP. Two-way causality has been found in the long run between GDP and ENC while one-way causality has been found in the short-term running from the ENC toward GDP. Apergis and Payne (2010b) check the connection between GDP and ENC with the multivariate structure and used Pedroni's test for the panel of heterogeneous co-integration and found a statistically significant and positive association between ENC and the GDP. Yildirim, Aslan, and Ozturk (2014) have investigated the connection between ENC and GDP for a group of eleven countries. Their findings confirmed the neutrality hypothesis for all countries excluding Turkey and have found a one-direction causality connection running from EC towards GDP. To check the causality association between ENC and GDP for seven Sub-Saharan African countries, Jacques Loesse (2010) has applied the Bound testing methodology and has found a co-integration between GDP and ENC. The finding shows a one-direction causal relationship running from the GDP to the ENC in Congo, Furthermore, a two-way causality association has been found between real GDP and ENC in, Congo, South Africa, Cameroon, and, Cote d'Ivoire.

While contrary to the above studies, some studies have found bidirectional short-term and the long-term causality association between GDP and ENC i.e. (Abu-Bader & Abu-Qarn, 2008; Akkemik & Göksal, 2012; Al-Mulali, Fereidouni, Lee, & Sab, 2013; Al-Yousif, 2002; Calderón & Liu, 2003; Demetriades & Hussein, 1996). Murry and Nan (1994) also found a two-direction causal association between GDP and the ENC in Malaysia. The study by Aqeel and Butt (2001) checks the causality association among GDP, ENC, and employment in the case of Pakistan. The result indicates that both the GDP and the gasoline consumption have no impact on one another while it leads to the growth of the use of petroleum. Zhang and Broadstock (2016) investigate the causality connection between EC and GDP. However, in only one study, panel granger causality has been found, as Kahouli (2017) examines the causality association among ENC, GDP, and urbanization (URB). The findings of the bivariate analysis show the causality association running from urbanization to GDP and ENC and from GDP to ENC, Furthermore, tri-variate analysis shows panel granger causality connection runs from GDP and ENC to URB, URB, and GDP towards ENC, and from URB and ENC to GDP. In their study, Shahbaz, Lean, and Farooq (2013) recheck the link between the GDP and ENC in the case of Pakistan. The finding shows that ENC granger causes the exports (X) and co-integration among variables. Furthermore, Shahbaz, Chaudhary, and Shahzad (2018) examine the association between ENC and foreign capital inflows by including currency devaluation, exports, and GDP for Pakistan. The findings indicate that in the long run currency depreciation and foreign capital inflows decrease the ENC. However, the feedback effect has been found between ENC and foreign capital inflows. Furuoka (2015) examines the association between ENC and FD in Asian countries. However, the finding shows that ENC causes FD and also found the long-term relationship between ENC and FD. Kakar (2016) explores the relationship between FD and ENC in Pakistan. Shahbaz, Islam, and Butt (2011) examine the connection between ENC, FD, and CO_2 emissions in Pakistan. Similarly in another study, Islam, Shahbaz, Ahmed, and Alam (2013) also examine the link between the ENC and the FD by incorporating industrialization and urbanization in the case of Malaysia. Furthermore, Danish, Shah, and Muhammad (2018) & Saud, Baloch, and Lodhi (2018) check the connection between the FD and ENC by incorporating industrialization in the case of Next-11 countries. In the energy-growth nexus some studies add the financial development variable and confirm that an association exists between FD, ENC and GDP e.g., (Chang, 2015; Islam et al., 2013; Kakar, 2016; Shahbaz & Lean, 2012). Furthermore, in existing literature, few studies examine the association between ENC and FD (Islam et al., 2013; Mahalik, Babu, Loganathan, & Shahbaz, 2017; Sadorsky, 2010).

The models and methods

Many studies have used different variables and different econometric methodologies to check the association of energy consumption with other variables. We have made some modifications in the model as we take some additional variables (industrialization, urbanization, foreign direct investment, trade, and energy prices) into our model. In the existing literature, none of the studies has checked the association of ENC with FD, GDP, IND, URB, FDI, trade, and energy prices in the same model for the South Asian region by using the Autoregressive distributed lag (ARDL) technique and the VECM Granger causality approach but here we have estimated this model by using advanced econometric methodologies. Several studies such as Manan (2016), Shahbaz and Lean (2012), and Sadorsky (2010) have incorporated the FD and GDP which is supposed to affect the ENC. Furthermore, FDI, trade, and energy prices also have been found to be affecting energy consumption (Bilgili, Koçak, Bulut, & Kuloğlu, 2017; Mahadevan & Asafu-Adjaye, 2007). Moreover, some other studies have added industrialization and urbanization to affect energy consumption (Manan, 2016; Shahbaz & Lean, 2012). Based on the above-mentioned studies, we utilize the model to examine the impact of the FD and GDP on ENC which is given below;

$$\ln ENC_{it} = \beta_0 + \beta_{it}\ln FD_{it} + \beta_{2t}\ln GDP_{it} + \beta_{3t}\ln IND_{it} + \beta_{4t}\ln URB_{it} + \beta_{5t}\ln FDI_{it} + \beta_{6t}\ln T_{it} + \ln EP_{it} + \varepsilon_{it} \qquad (1)$$

In equation (1) i= 1……. N indicates the country and t= 1…...T represents time. ENC represents the consumption of energy (kg of the oil equivalent per capita), where the FD is going to be used to represent the financial development (domestic credit to the private sector percentage of the GDP), GDP is the economic growth (constant 2010 US$), IND is the industrialization (industry including construction % of GDP), URB denotes to the urbanization (urban population % of the total population), FDI is the foreign direct investment (net inflows % of the GDP), T is the trade (% of the GDP) and EP is the energy price (consumer price index CPI 2010=100) and ε_{it} is the residual term that is considered to be normally distributed having the zero mean and the constant variance. Furthermore, all the variables which are included in this model are taken in the log form.

Econometric Methodology

Data

For empirical purposes pannel data for South Asian region (i.e., Pakistan, India, Bangladesh, Sri Lanka and, Nepal) from 1991 to 2020 were obtained from the World development Index (WDI). Description of variables given below;

Table 1: Variables description

Variables	Notations	Unit
Energy Consumption`	ENC	Energy use (kg of the oil equivalent per capita)
Financial Development	FD	Domestic credit to the private sector (% of the GDP)
Economic Growth	GDP	GDP (constant 2010 US$)
Industrialization	IND	Industry (including construction) value-added [% of GDP]
Urbanization	URB	Urban population (% of the total population)
Foreign Direct Investment	FDI	FDI, net inflows (% of the GDP)
Trade	T	Trade (% of the GDP)
Energy Price	P	Consumer price index (CPI) [2010=100]

Source: World Development Indicators

Panel Unit Root Test

In the case of the panel data context, several unit root tests have been given to understand the characteristics of stationarity. However, it is necessary to analyze the stationarity of the data before the estimation because the estimation of non-stationary data gives us spurious results. The present study employed the Levin-Lin-Chu test proposed by Beck and Levine (2004), the Breitung unit root test, and the IM-Pesaran unit root test assumes the cross-sectional independence and ADF Fisher-type test presented by the Maddala and Wu (1999) and Choi (2001) to check the null hypothesis (Ho) that variables are non-stationary means having unit root. While Levin-Lin-Chu and Breitung tests are used for the common unit root process while IPS and the Fisher ADF test assume that an individual unit root process across the cross sections exists.

Co-integration analysis

Kao test for Co-integration

Kao presented (1999) the panel co-integration test namely the Kao test which is similar to the Dickey-Fuller (DF) and the Augmented Dickey-Fuller (ADF) type techniques. The model can be written as follow

$$Y_{it} = \alpha_i + \beta X_{it} + \hat{u}_{it}$$

The residual test for co-integration could be applied according to the above equation.

$$\hat{u}_{it} = \rho\hat{u}_{it-1} + v_{it}$$

$\hat{u}_{it}$ = estimated residual from the 1st equation. The OLS estimate for the co-efficient (ρ) is given below

$$\hat{\rho} = \frac{\sum_{i=1}^{N}\sum_{t=2}^{T}\hat{u}_{it}\,\hat{u}_{it-1}}{\sum_{i=1}^{N}\sum_{t=2}^{T}\hat{u}^2_{it}}$$

The equation of t statistic is written below

$$t_\rho = \frac{(\hat{\rho}-1)\sqrt{\sum_{i=1}^{N}\sum_{t=2}^{T}\hat{u}^2_{it}}}{1/_{(NT)}\sum_{i=1}^{N}\sum_{t=2}^{T}(\hat{u}_{it} - \hat{\rho}\,\hat{u}_{it-1})^2}$$

Furthermore, Kao presents the four different forms of the Dickey fuller methodology that are given below

$$DF \quad \rho = \frac{\sqrt{NT}\,(\hat{\rho}-1)\,3\sqrt{N}}{\sqrt{10.2}}$$

$$DF \quad t = \sqrt{1.25t_\rho} + \sqrt{1.785N}$$

$$DF \quad \dot{\rho} = \frac{\sqrt{NT}(\hat{\rho}-1)+3\sqrt{N}\,\sigma^2{}_v/\sigma^2{}_{0v}}{\sqrt{3+36\,\hat{\sigma}^4{}_v/(5\hat{\sigma}^4{}_{0v})}}$$

$$DF \quad \dot{t} = \frac{t_\rho+\sqrt{6N}\,\hat{\sigma}_v/(2\hat{\sigma}_{0v})}{\sqrt{\hat{\sigma}^2{}_{0v}/(2\hat{\sigma}^2{}_v)+3\hat{\sigma}^2{}_v/(10\hat{\sigma}^2{}_{0v})}}$$

The relationship between errors and the regressors is considered to be strongly exogenous in the two first two equations, while in the last two equations the association between the errors and the regressors is endogenous. An Augmented Dickey-Fuller (DF) test has also been presented by Kao (1999) which is given as

$$u_{i,t} = \rho u_{i,t-1} + \sum_{j=1}^{n}\phi_j\,\Delta u_{i,t-j} + v_{it}$$

The null hypothesis of the Augmented Dickey-Fuller test is the absence of co-integration while the alternative hypothesis is that co-integration is present among the variables. The statistics of the ADF test follow the Standard normal distribution and can be calculated as follows

$$ADF = \frac{t_{ADF}+\sqrt{6N\hat{\sigma}_v}/(2\hat{\sigma}_{0v})}{\sqrt{\hat{\sigma}^2{}_{0v}/(2\hat{\sigma}^2{}_{0v})+3\hat{\sigma}^2{}_v/(10\hat{\sigma}^2{}_{0v})}}$$

Padroni's tests of co-integration

The co-integration tests recommended by Padroni (1997, 1999, and 2000) permit considerable heterogeneity in the case of panel data models. The panel regression model for Pedroni is presented in the following section

$$Y_{i,t} = \alpha_i + \delta_t + \sum_{m=1}^{M}\beta_{mi}X_{mi,t} + \mu_{i,t}$$

For the detection of between and within-dimension effects in his, model Pedroni suggested seven different types of co-integration statistics. Pedroni classified the co-integration test into two different categories. In the first category, four tests are incorporated, which are depending on the pooling (besides the within dimension). These tests are almost alike to the previous co-integration tests, furthermore, the test statistics can be written as follow

Panel v-statistic:

$$T^2N^{2/3}Z_{\hat{v}NT} = \frac{T^2N^{2/3}}{(\sum_{i=1}^{N}\sum_{t=1}^{T}\hat{L}^{-2}{}_{11i}\hat{u}^2{}_{it})}$$

Panel ρ statistic:

$$T\sqrt{N}Z_{\hat{\rho}NT} = \frac{T\sqrt{N}(\sum_{i=1}^{N}\sum_{t=1}^{T}\hat{L}^{-2}{}_{11i}(\hat{u}^2{}_{it-1}\Delta\hat{u}^2{}_{it}-\hat{\lambda}_i))}{(\sum_{i=1}^{N}\sum_{t=1}^{T}\hat{L}^{-2}{}_{11i}\hat{u}^2{}_{it})}$$

Panel t-statistic (non-parametric form)

$$Z_{tNT} = \sqrt{\tilde{\sigma}^2{}_{NT}\sum_{i=1}^{N}\sum_{t=1}^{T}\hat{L}^{-2}{}_{11i}\,\hat{u}^2{}_{it-1}}\,(\sum_{i=1}^{N}\sum_{t=1}^{T}\hat{L}^{-2}{}_{11i}(\hat{u}^2{}_{it-1}\Delta\hat{u}^2{}_{it} - \lambda_i))$$

Panel t-statistics (Parametric form)

$$Z_{tNT} = \sqrt{\tilde{\sigma}^{*2}{}_{NT}\sum_{i=1}^{N}\sum_{t=1}^{T}\hat{L}^{-2}{}_{11i}\,\hat{u}^{*2}{}_{it-1}}\,(\sum_{i=1}^{N}\sum_{t=1}^{T}\hat{L}^{-2}{}_{11i}(\hat{u}^{*2}{}_{it-1}\Delta\hat{u}^{*2}{}_{it} - \lambda_i))$$

The other three types of (between dimension) Pedroni co-integration tests are incorporated in the second category, the other three test statistics are given below.

Group ρ statistic (parametric form)

$$T\sqrt{N}\tilde{Z}_{\tilde{\rho}NT} = T\sqrt{N}\,\frac{\sum_{t=1}^{T}(\hat{u}^2{}_{it-1}\Delta\hat{u}^2{}_{it}-\hat{\lambda}_i)}{\sum_{i=1}^{N}(\sum_{t=1}^{T}\hat{u}^2{}_{it-1})}$$

Panel t-statistic (non-parametric form)

$$\sqrt{N}\tilde{Z}_{tNT-1} = \sqrt{N}\sum_{i=1}^{N}(\sqrt{\tilde{S}^{*2}{}_i\sum_{t=1}^{T}\hat{u}^{*2}{}_{it-1}})\sum_{t=1}^{T}(\hat{u}^{*2}{}_{it-1}\Delta\hat{u}^{*2}{}_{it})$$

Panel t-statistic (parametric form)

$$\sqrt{N}\tilde{Z}_{tNT-1} = \sqrt{N}\sum_{i=1}^{N}(\sqrt{\tilde{\sigma}^2{}_i\sum_{t=1}^{T}\hat{u}^2{}_{it-1}})\sum_{t=1}^{T}(\hat{u}^2{}_{it-1}\Delta\hat{u}^2{}_{it} - \hat{\lambda}_i)$$

Panel Autoregressive Distributed Lag (ARDL) Approach

In panel ARDL we have two different types of estimators. First is the "Pooled Mean Group estimator" (PMG) and the second is the "Mean Group (MG) Model". Furthermore, the speed of the adjustment (ECT) about the long-term equilibrium and the error variances are supposed to be heterogeneous country by country, whereas on the other hand the long-term slope coefficients are constrained to be homogenous across the states. In the PMG model, the long-term co-efficient might change from the error variances but the long-run co-efficient is to be equivalent to the error correction model. Furthermore, the PMG estimator is constructed under the postulation of heterogeneity of the long-term slope coefficients (Pesaran, Shin, & Smith, 1999). The primary conditions are treated as fixed or random and the long-term co-efficient are the combinations of the short-run coefficients. However, the base of the Pooled Mean Group (PMG) is the estimation of the Autoregressive Distributed Lag (ARDL) model (m_i, n_i, p_i, q_i, s_i, v_i, w_i, z_i).

Furthermore, the ARDL model includes the long-run relationship between the variables according to Pesaran et al. (1999) which can be written in the following form.

$$\Delta ENC_{it} = \alpha_i + \sum_{j=1}^{m-1} \beta_{ij} \Delta ENC_{i,t-j} + \sum_{l=0}^{n-1} \varphi_{il} \Delta FD_{i,t-l} + \sum_{r=0}^{p-1} \gamma_{ir} \Delta GDP_{i,t-r} + \sum_{h=0}^{q-1} \theta_{ih} \Delta IND_{i,t-h} + \sum_{u=0}^{s-1} \delta_{iu} \Delta URB_{i,t-u} + \sum_{x=0}^{v-1} \rho_{ix} \Delta FDI_{i,t-x} + \sum_{d=0}^{w-1} \eta_{id} \Delta T_{i,t-d} + \sum_{g=0}^{z-1} \zeta_{ig} \Delta EP_{i,t-g} + \sigma_1 ENC_{i,t-1} + \sigma_2 FD_{i,t-1} + \sigma_3 GDP_{i,t-1} + \sigma_4 IND_{i,t-1} + \sigma_i URB_{i,t-1} + \sigma_i FDI_{i,t-1} + \sigma_i T_{i,t-1} + \sigma_i EP_{i,t-1} + \varepsilon_{1i,t} \quad (2a)$$

$$\Delta FD_{it} = \alpha_i + \sum_{j=1}^{m-1} \beta_{ij} \Delta FD_{i,t-j} + \sum_{l=0}^{n-1} \varphi_{il} ENC + \sum_{r=0}^{p-1} \gamma_{ir} \Delta GDP_{i,t-r} + \sum_{h=0}^{q-1} \theta_{ih} \Delta IND_{i,t-h} + \sum_{u=0}^{s-1} \delta_{iu} \Delta URB_{i,t-u} + \sum_{x=0}^{v-1} \rho_{ix} \Delta FDI_{i,t-x} + \sum_{d=0}^{w-1} \eta_{id} \Delta T_{i,t-d} + \sum_{g=0}^{z-1} \zeta_{ig} \Delta EP_{i,t-g} + \sigma_1 FD_{i,t-1} + \sigma_2 ENC_{i,t-1} + \sigma_3 GDP_{i,t-1} + \sigma_4 IND_{i,t-1} + \sigma_i URB_{i,t-1} + \sigma_i FDI_{i,t-1} + \sigma_i T_{i,t-1} + \sigma_i EP_{i,t-1} + \varepsilon_{1i,t} \quad (2b)$$

$$\Delta GDP_{it} = \alpha_i + \sum_{j=1}^{m-1} \beta_{ij} \Delta GDP_{i,t-j} + \sum_{l=0}^{n-1} \varphi_{il} \Delta ENC_{i,t-l} + \sum_{r=0}^{p-1} \gamma_{ir} \Delta FD_{i,t-r} + \sum_{h=0}^{q-1} \theta_{ih} \Delta IND_{i,t-h} + \sum_{u=0}^{s-1} \delta_{iu} \Delta URB_{i,t-u} + \sum_{x=0}^{v-1} \rho_{ix} \Delta FDI_{i,t-x} + \sum_{d=0}^{w-1} \eta_{id} \Delta T_{i,t-d} + \sum_{g=0}^{z-1} \zeta_{ig} \Delta EP_{i,t-g} + \sigma_1 GDP_{i,t-1} + \sigma_2 ENC_{i,t-1} + \sigma_3 FD_{i,t-1} + \sigma_4 IND_{i,t-1} + \sigma_i URB_{i,t-1} + \sigma_i FDI_{i,t-1} + \sigma_i T_{i,t-1} + \sigma_i EP_{i,t-1} + \varepsilon_{1i,t} \quad (2c)$$

$$\Delta IND_{it} = \alpha_i + \sum_{j=1}^{m-1} \beta_{ij} \Delta IND_{i,t-j} + \sum_{l=0}^{n-1} \varphi_{il} \Delta ENC_{i,t-l} + \sum_{r=0}^{p-1} \gamma_{ir} \Delta FD_{i,t-r} + \sum_{h=0}^{q-1} \theta_{ih} \Delta GDP_{i,t-h} + \sum_{u=0}^{s-1} \delta_{iu} \Delta URB_{i,t-u} + \sum_{x=0}^{v-1} \rho_{ix} \Delta FDI_{i,t-x} + \sum_{d=0}^{w-1} \eta_{id} \Delta T_{i,t-d} + \sum_{g=0}^{z-1} \zeta_{ig} \Delta EP_{i,t-g} + \sigma_1 IND_{i,t-1} + \sigma_2 ENC_{i,t-1} + \sigma_3 FD_{i,t-1} + \sigma_4 GDP_{i,t-1} + \sigma_i URB_{i,t-1} + \sigma_i FDI_{i,t-1} + \sigma_i T_{i,t-1} + \sigma_i EP_{i,t-1} + \varepsilon_{1i,t} \quad (2d)$$

$$\Delta URB_{it} = \alpha_i + \sum_{j=1}^{m-1} \beta_{ij} \Delta URB_{i,t-j} + \sum_{l=0}^{n-1} \varphi_{il} \Delta ENC_{i,t-l} + \sum_{r=0}^{p-1} \gamma_{ir} \Delta FD_{i,t-r} + \sum_{h=0}^{q-1} \theta_{ih} \Delta GDP_{i,t-h} + \sum_{u=0}^{s-1} \delta_{iu} \Delta IND_{i,t-u} + \sum_{x=0}^{v-1} \rho_{ix} \Delta FDI_{i,t-x} + \sum_{d=0}^{w-1} \eta_{id} \Delta T_{i,t-d} + \sum_{g=0}^{z-1} \zeta_{ig} \Delta EP_{i,t-g} + \sigma_1 URB_{i,t-1} + \sigma_2 ENC_{i,t-1} + \sigma_3 FD_{i,t-1} + \sigma_4 GDP_{i,t-1} + \sigma_i IND_{i,t-1} + \sigma_i FDI_{i,t-1} + \sigma_i T_{i,t-1} + \sigma_i EP_{i,t-1} + \varepsilon_{1i,t} \quad (2e)$$

$$\Delta FDI_{it} = \alpha_i + \sum_{j=1}^{m-1} \beta_{ij} \Delta FDI_{i,t-j} + \sum_{l=0}^{n-1} \varphi_{il} \Delta ENC_{i,t-l} + \sum_{r=0}^{p-1} \gamma_{ir} \Delta FD_{i,t-r} + \sum_{h=0}^{q-1} \theta_{ih} \Delta GDP_{i,t-h} + \sum_{u=0}^{s-1} \delta_{iu} \Delta IND_{i,t-u} + \sum_{x=0}^{v-1} \rho_{ix} \Delta URB_{i,t-x} + \sum_{d=0}^{w-1} \eta_{id} \Delta T_{i,t-d} + \sum_{g=0}^{z-1} \zeta_{ig} \Delta EP_{i,t-g} + \sigma_1 FDI_{i,t-1} + \sigma_2 ENC_{i,t-1} + \sigma_3 FD_{i,t-1} + \sigma_4 GDP_{i,t-1} + \sigma_i IND_{i,t-1} + \sigma_i URB_{i,t-1} + \sigma_i T_{i,t-1} + \sigma_i EP_{i,t-1} + \varepsilon_{1i,t} \quad (2f)$$

$$\Delta T_{it} = \alpha_i + \sum_{j=1}^{m-1} \beta_{ij} \Delta T_{i,t-j} + \sum_{l=0}^{n-1} \varphi_{il} \Delta ENC_{i,t-l} + \sum_{r=0}^{p-1} \gamma_{ir} \Delta FD_{i,t-r} + \sum_{h=0}^{q-1} \theta_{ih} \Delta GDP_{i,t-h} + \sum_{u=0}^{s-1} \delta_{iu} \Delta IND_{i,t-u} + \sum_{x=0}^{v-1} \rho_{ix} \Delta URB_{i,t-x} + \sum_{d=0}^{w-1} \eta_{id} \Delta FDI_{i,t-d} + \sum_{g=0}^{z-1} \zeta_{ig} \Delta EP_{i,t-g} + \sigma_1 T_{i,t-1} + \sigma_2 ENC_{i,t-1} + \sigma_3 FD_{i,t-1} + \sigma_4 GDP_{i,t-1} + \sigma_i IND_{i,t-1} + \sigma_i URB_{i,t-1} + \sigma_i FDI_{i,t-1} + \sigma_i EP_{i,t-1} + \varepsilon_{1i,t} \quad (2g)$$

$$\Delta EP_{it} = \alpha_i + \sum_{j=1}^{m-1} \beta_{ij}\Delta EP_{i,t-j} + \sum_{l=0}^{n-1} \varphi_{il}\Delta ENC_{i,t-l} + \sum_{r=0}^{p-1} \gamma_{ir}\Delta FD_{i,t-r} + \sum_{h=0}^{q-1} \theta_{ih}\Delta GDP_{i,t-h} + \sum_{u=0}^{s-1} \delta_{iu}\Delta IND_{i,t-u} + \sum_{x=0}^{v-1} \rho_{ix}\Delta URB_{i,t-x} + \sum_{d=0}^{w-1} \eta_{id}\Delta FDI_{i,t-d} + \sum_{g=0}^{z-1} \zeta_{ig}\Delta T_{i,t-g} + \sigma_1 EP_{i,t-1} + \sigma_2 ENC_{i,t-1} + \sigma_3 FD_{i,t-1} + \sigma_4 GDP_{i,t-1} + \sigma_i IND_{i,t-1} + \sigma_i URB_{i,t-1} + \sigma_i FDI_{i,t-1} + \sigma_i T_{i,t-1} + \varepsilon_{1i,t} \quad (2h)$$

Where ENC_{it}, FD_{it}, GDP_{it}, IND_{it}, URB_{it}, FDI_{it}, and EP_{it} indicates the log of the dependent variables, α_i represents the co-efficient that expressed the specific country, while the coefficients of the short-run dynamics are β_{ij}, φ_{il}, γ_{ir}, θ_{ih}, δ_{iu}, ρ_{ix}, η_{id}, ζ_{ig} that are related to each country and ε_{it} is the residual term in the model. Furthermore, it is assumed that long-term coefficients are identical to whole countries. Moreover, we can say that long-term association exists between dependent and independent variables if the value of β_{ij} is negative and significant. The PMG methodology is in the form of panel ARDL technique and can be used to estimate the autoregressive distributed lag model through the maximum likelihood.

VECM Granger Causality Approach

We used the panel VECM test proposed by Engle and Granger (1987) to examine the causal association among the different variables. Firstly, we estimate the long-term model to find the residuals by adopting the two-step procedure.

$$\ln ENC_{it} = \alpha_{it} + \delta_i t + \gamma_{1i}\ln FD_{it} + \gamma_{2i}\ln GDP_{it} + \gamma_{3i}\ln IND_{it} + \gamma_{4i}\ln URB_{it} + \gamma_{5i}\ln FDI_{it} + \gamma_{6i}\ln T_{it} + \gamma_{7i}\ln EP_{it} + \varepsilon_{it} \quad (3)$$

In the VECM model, the direction of the causality association among the variables is tested in the panel context. When the co-integration is present among the variables, it indicates that the long-term relationship among the variables, more, the causality exists among variables in at least one of the directions (Engle & Granger, 1987; Oxley & Greasley, 1998). Furthermore, the ECT term can also be incorporated into the model. As a result, Vector Error Correction Model (VECM) is constructed to reestablish the information missing in the process of differentiation and establish the short-run as well as the long-term equilibrium. Furthermore, the (ECT_{t-1}) is the lagged value of the residuals, the error-correcting dynamics model can be represented as follow: The panel VECM is specified as above (Belloumi, 2009; Pao & Tsai, 2011), Δ indicates to the first difference, αi is the representation of the constant term, λ is the parameter; where t=1,…., T represents to the time period where i=1,……, N indicates to the country or individuals, ECT is considered the lagged error term and derived from the long-term co-integrating association while ε_{it} is the representation of the error term which is supposed to be serially uncorrelated.

$$\begin{bmatrix} \Delta LnENC_{it} \\ \Delta LnFD_{it} \\ \Delta LnGDP_{it} \\ \Delta LnIND_{it} \\ \Delta LnURB_{it} \\ \Delta LnFDI_{it} \\ \Delta LnT_{it} \\ \Delta LnP_{it} \end{bmatrix} = \begin{bmatrix} \alpha_1 \\ \alpha_2 \\ \alpha_3 \\ \alpha_4 \\ \alpha_5 \\ \alpha_6 \\ \alpha_7 \\ \alpha_8 \end{bmatrix} + \sum_{p=1}^{r} \begin{bmatrix} \beta_{11p} & \beta_{12p} & \beta_{13p} & \beta_{14p} & \beta_{15p} & \beta_{16p} & \beta_{17p} & \beta_{18p} \\ \beta_{21p} & \beta_{22p} & \beta_{23p} & \beta_{24p} & \beta_{25p} & \beta_{26p} & \beta_{27p} & \beta_{28p} \\ \beta_{31p} & \beta_{32p} & \beta_{33p} & \beta_{34p} & \beta_{35p} & \beta_{36p} & \beta_{37p} & \beta_{38p} \\ \beta_{41p} & \beta_{42p} & \beta_{43p} & \beta_{44p} & \beta_{45p} & \beta_{46p} & \beta_{47p} & \beta_{48p} \\ \beta_{51p} & \beta_{52p} & \beta_{53p} & \beta_{54p} & \beta_{55p} & \beta_{56p} & \beta_{57p} & \beta_{58p} \\ \beta_{61p} & \beta_{62p} & \beta_{63p} & \beta_{64p} & \beta_{65p} & \beta_{66p} & \beta_{67p} & \beta_{68p} \\ \beta_{71p} & \beta_{72p} & \beta_{73p} & \beta_{74p} & \beta_{75p} & \beta_{76p} & \beta_{77p} & \beta_{78p} \\ \beta_{81p} & \beta_{82p} & \beta_{83p} & \beta_{84p} & \beta_{85p} & \beta_{86p} & \beta_{87p} & \beta_{88p} \end{bmatrix} \times \begin{bmatrix} \Delta LnENC_{it-p} \\ \Delta LnFD_{it-p} \\ \Delta LnGDP_{it-p} \\ \Delta LnIND_{it-p} \\ \Delta LnURB_{it-p} \\ \Delta LnFDI_{it-p} \\ \Delta LnT_{it-p} \\ \Delta LnP_{it-p} \end{bmatrix} + \begin{bmatrix} \lambda_1 \\ \lambda_2 \\ \lambda_3 \\ \lambda_4 \\ \lambda_5 \\ \lambda_6 \\ \lambda_7 \\ \lambda_8 \end{bmatrix} (ECT_{it-1}) + \begin{bmatrix} \varepsilon_{1it} \\ \varepsilon_{2it} \\ \varepsilon_{3it} \\ \varepsilon_{4it} \\ \varepsilon_{5it} \\ \varepsilon_{6it} \\ \varepsilon_{7it} \\ \varepsilon_{8it} \end{bmatrix}$$

The optimal lag length is selected in each equation through AIC and HQ criteria (Pao & Tsai, 2011).

The results

Panel Co-integration Test Results

Pedroni (1999; 2004) suggests several co-integration tests for panel analysis based on co-integrating residuals ε_{it} i.e. the between dimension. The between-dimension tests are formulated by dividing the numerator with the de-numerator earlier adding over the N dimensions. The remaining other four tests are based on the within-dimension tests that can be stated as panel co-integration tests and obtained after adding both de-numerator and numerator statistics separately over the N dimension. Here we used the Kao test and Pedroni (2004; 1999) panel co-integration test as a benchmark. These tests are used to examine the residuals. The residuals must be stationary when the variables are co-integrated. The results of the Kao and Pedroni's panel co-integration tests show that in the South Asian region we can reject the (Ho) in the Panel V-statistic means co-integration exists, the Panel PP-statistic, Panel ADF-statistic, Group PP-statistic, and the Group ADF-statistic at 1% the level of the significance. However, we can conclude that co-integration exists among all of them.

Panel ARDL results

The MG and PMG were recommended by Pesaran et al. (1999) and Pesaran and Smith (1995). These two estimators are based on the Autoregressive Distributive Lag (ARDL) model and Maximum Likelihood procedure by taking into account the long-run equilibrium along with accounting for the heterogeneity of the adjustment process (Demetrades & Law 2006). Though the Mean Group (MG) estimates are persistent, Pesaran and Smith (1995) discussed that these estimates become more reliable if the long-term homogeneity restrictions are accurate, and in this scenario, the MG estimates will be ineffectual which may give ambiguous results.

Table 2: Pedroni's and Kao Panel Co-integration test results for South Asian countries

Pedroni Test	
Alternative hypothesis: the common AR co-eff. (within dimension)	
Panel v-Statistic	2.3856***
	1.6375**
Panel rho-Statistic	1.2123
	1.2053
Panel PP- Statistic	-2.0990***
	-2.3714***
Panel ADF- Statistic	-2.1188***
	-2.3756***
Alternative hypothesis: individual AR co-eff (between dimensions)	
Group rho-Statistic	1.8348
Group PP- Statistic	-2.5130***
Group ADF- Statistic	-2.5174***
Kao Test	
	-0.257

Note: here, ***, **, *, indicates significance at the 1% if (P<0.01), at the 5% if (p<0.05) and at the 10% (p<0.1)

Table 3: PMG short-run estimate for South Asian Countries

	BRICS Countries		
Variables	**Co-efficient**	**t-stat**	**P-value**
Constant	-0.0070	-1.348383	(0.18)
D(ENC(-1))	0.4951***	4.460772	(0.00)
D(FD)	0.0002*	-2.040981	(0.07)
D(FD(-1))	-0.0005	-1.563087	(0.12)
D(GDP)	0.6337***	7.750008	(0.00)
D(GDP(-1))	-0.4098***	-4.066646	(0.00)
D(IND)	0.0039*	2.441908	(0.01)
D(IND(-1))	-0.0009	-0.555596	(0.57)
D(URB)	0.0273	0.499809	(0.61)
D(URB(-1))	-0.0213	-0.390390	(0.69)
D(FDI)	0.0036*	2.000124	(0.08)
D(FDI(-1))	-0.0001	-0.046386	(0.96)
D(T)	0.0001	0.294956	(0.76)
D(T(-1))	-2.1301	-0.050463	(0.95)
D(P)	-0.0006*	2.582694	(0.01)
D(P(-1))	-0.0004	0.489663	(0.62)
ECT(-1)	-0.0832***	-5.752407	(0.00)

Note: The values in the parenthesis are the corresponding P-values. ECT: Speed of Adjustment Co-efficient. Here, ***, **, *, indicates significance at the 1% if ($P<0.01$), at the 5% if ($p<0.05$) and at the 10% ($p<0.1$)

The above empirics show that short-run PMG results. As the outcomes show, that the co-efficient of the ECT term has negative sign and also statistically significant this suggests that a long-term association is present among the variables. Likewise, we can also assume ENC, FD, GDP, industrialization, urbanization, FDI trade, and the price, in the long run, have similar trends of movement. Moreover, when the co-efficient of the ECT term is less than one in the absolute term, it shows that the system is dynamically stable and converges towards the long-run equilibrium (Khan, Rehan, Chhapra, & Bai, 2022). Moreover, financial development, trade, urbanization, and foreign direct investment have the statistically insignificant effect on the ENC. Consequently, In the short run the results are mixed (Komal & Abbas, 2015; Mujtaba, Jena, Bekun, & Sahu, 2022).

Table 4: PMG Long run-results for South Asian Countries

Independent Variables	**Dependent Variables**							
	ENC	FD	GDP	IND	URB	FDI	T	P
ENC		4.0087	-10.7***	2.5748	12.278***	0.1346	-155.48*	-29.361
		(0.90)	(0.00)	(0.38)	(0.00)	(0.73)	(0.06)	(0.77)
FD	0.0005***		0.036**	0.0009	-0.117*	0.0011	0.0508	-0.9873

	(0.00)		(0.03)	(0.98)	(0.07)	(0.80)	(0.83)	(0.19)
GDP	0.11117***	-8.044*		3.7794	1.0689*	-0.0158	-12.85***	4.0393
	(0.00)	(0.09)		(0.51)	(0.06)	(0.68)	(0.00)**	(0.63)
IND	-0.0009	1.0984	0.0148		-0.4692**	0.0416**	1.0013	5.1169
	(0.61)	(0.31)	(0.85)		(0.04)	(0.02)	(0.55)	(0.22)
URB	0.1304***	-2.514	0.4785**	1.6923		0.0517*	4.2070	-8.1992
	(0.00)	(0.11)	(0.02)	(0.65)		(0.11)	(0.15)	(0.19)
FDI	-0.0176***	3.684***	0.2691	3.174***	0.0120		5.7313	8.1917
	(0.00)	(0.00)	(0.27)	(0.00)	(0.96)		(0.02)	(0.43)
T	0.0034***	-0.1709*	-0.04***	0.1501***	0.0293*	4.160		-0.6659
	(0.00)	(0.09)	(0.00)	(0.00)	(0.06)	(0.98)		(0.38)
P	-0.0019***	0.1035	0.029***	0.0417	-0.0771**	0.0015	-0.1440*	
	(0.00)	(0.21)	(0.00)	(0.54)	(0.02)	(0.27)	(0.09)	

Note: The values in the parenthesis are the corresponding P-values. Here, ***, **, *, indicates the significance at the 1% if (P<0.01), at the 5% if (p<0.05) and at the 10% if (p<0.1)

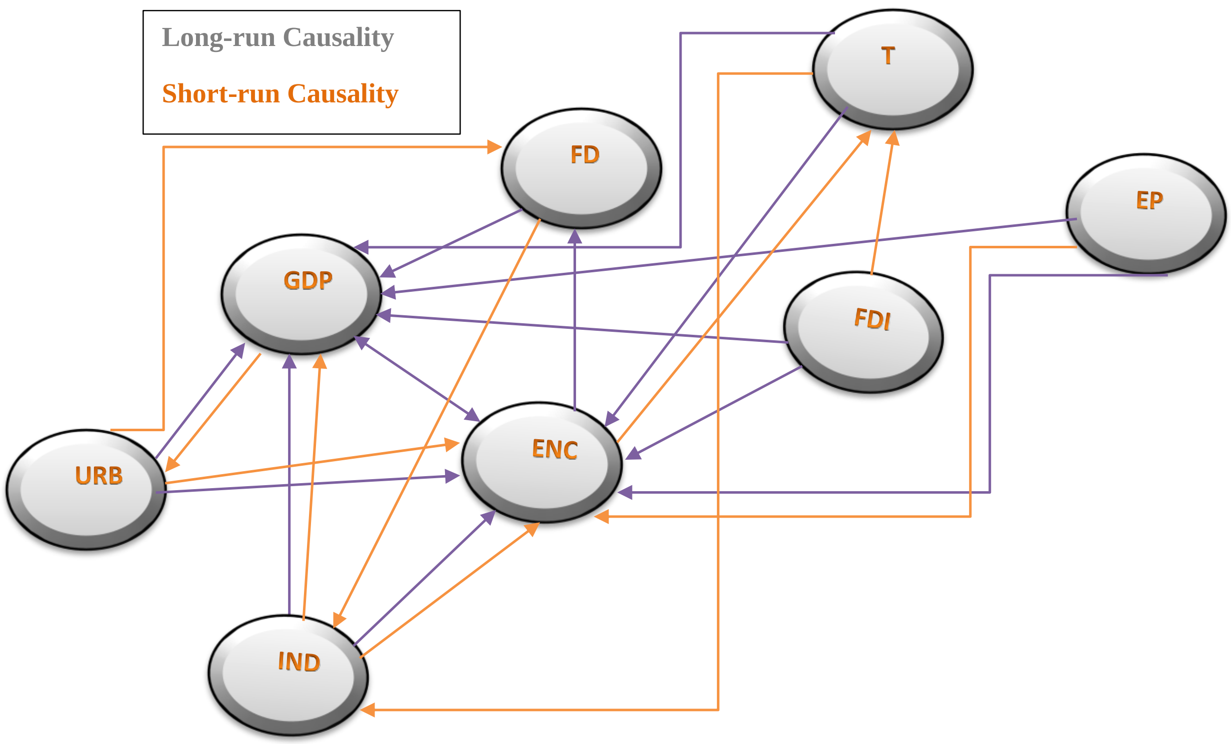
The above results show that the effect of GDP and FD on ENC is positive and significant at the 1% level of significance. The positive association between the GDP, FD, and the ENC indicates that as GDP and FD increase, it requires more energy hence these both are essential for the development of the economy. Furthermore, the positive association of FD with ENC shows that financial sector development derives the ENC through domestic and industrial users in these countries. Likewise, policies that are aimed at the development of the financial sector has also implications for energy demand in South Asian countries. Similarly, the long-run impact of URB is positive and significant on ENC which indicates that more people living in the urban areas encourage housing and economic activities that lead to the many structural shifts in the economy which all become cause to increase in the energy demand. In other words, URB proceeds, people tend to use modern energy products, household appliances, and transportation, and new ENC patterns steadily emerge these all become cause to increase in the ENC. Likewise, the impact of IND is negative and insignificant on ENC. Furthermore, ENC decreases with the increase in FDI and prices. However, the price is negatively associated with the ENC which follows the law of demand. Trade has a positive impact on ENC(Ali, Gohar, Chang, & Wong, 2022).

VECM Granger causality test results

In the VECM Granger causality methodology, the direction of the causality between ENC, FD, GDP, URB, IND, foreign direct investment, trade, and energy prices is to be tested in the panel context. When the co-integration is present among the variables, it indicates the long-term connection among the variables. Moreover, causality exists among the variables in at least one direction (Engle & Granger, 1987; Oxley & Greasley, 1998).

The above figure shows that the one-way causality relationship is running from the GDP towards ENC, which is similar to the results of (Aqeel & Butt, 2001) and (Asghar, 2008). These findings support the conservation hypothesis which suggests that economies are comparatively less dependent on energy and also maintaining the same level of energy consumption (by using different measures such as a decrease of greenhouse gas emissions, and energy demand managing strategies) will have a marginal effect on the GDP. Many studies in literature, support our results e.g.Ozturk et al. (2010), Masih and Masih (1996) in the case of Indonesia and Pakistan, and Huang et al. (2008) for the Lower and Upper Middle-income groups. Hye and Riaz (2008) confirmed the causality from GDP to ENC in Pakistan. Additionally, FD causes the ENC in this region. The uni-directional causality is running from FD, GDP, IND, URB, FDI, trade, and price towards ENC, from ENC, FD, IND, URB, FDI, trade, and price towards GDP in the period of the long run. However, the results in the short run indicate an absence of the causality between the FD and the GDP, FDI and FD, price and FD, FDI and GDP, URB and IND, FDI and IND, FDI and URB, trade and URB, URB, and price, FDI and trade. Likewise, one-way causality is running from IND to ENC, URB to ENC, FDI to trade, price to ENC, URB to FD, ENC to trade, IND to GDP, GDP to URB, IND to trade, and FD to IND.

Fig#2



Conclusion and the recommendations

The basic objective of this empirical examination is to examine the short-run as well as the long-run relationship and the direction of the causality between FD, GDP, and ENC in South Asian countries, For empirical analysis, we use the annual data from 1991-2020. We employ different unit-root tests, e.g. the Levin Lin Chu (LLC) unit root test, Fisher ADF chi-square test, and Breitung unit root test including the IM-Pesaran-Shin Unit root approach to analyze the stationarity of the data. Likewise, we used the Schwarz-Bayesian Criterion (SIC) and the Hannan-Quinn (HQ) information criterion for the purposes of optimal lag selection. The results indicate that one or two of the variables are I(0) while the other variables are I(1). Additionally, none of the variables is integrated into order two. After these steps, we employ the Pedroni (2004; 1999) and Kao panel co-integration test. The finding of these tests indicates that the co-integration exists among the variables. After the confirmation of the co-integration, we apply the Panel ARDL and the VECM Granger causality approach. Furthermore, the outcomes of the PMG short-run approach show that the co-efficient of the ECT term has a negative significant value. This significant value of the coefficient of the ECT term shows that a long-term relationship exists among the variables. Whereas, the PMG long-run results indicate that the impact of the economic growth on energy consumption (ENC) is positive as well as significant which shows that economic growth can be achieved with more energy consumption generally. Furthermore, the impact of the FD on the ENC is also positive and statistically significant. This indicates that with the increase in the FD, the ENC will also go to increase. However, more easy access to loans, debts, or to credits would lead to an increase in the confidence of the investors for more business activities as a result the demand for energy will also be increased. Along with this, financial resources to the customers at a low rate of interest inspire the common man to borrow more than before, hence this leads to an increase in the purchasing power of the public for durable products e.g., air conditioners, vehicles, and refrigerators, these all increase the demand for energy. Likewise, FD encourages manufacturing growth and enables to build of new plants and factories that all enhance the demand for the energy. Moreover, an increase in the GDP also increases the demand for the energy. Another view is that increasing economic activities (consumption, purchases, and investment) will also lead to an increase in the demand for energy.

The findings of the that VECM Granger causality approach show the one-way causal connection exists, running from the GDP to ENC means GDP stimulates ENC. This also shows that a reduction in energy use will not have a substantial effect on the GDP hence the energy conservation policies in this region will decrease the unnecessary loss of energy. In the other words, in these regions, our empirical findings support to the “conservation hypothesis”. However, when energy use increases with the increase in GDP then in this form the externality cost of ENC will be set back to GDP. We can also say based on empirical results, that these countries are less energy-dependent and also maintaining the same level of ENC (by using different measures such as a decrease of greenhouse gas emissions and energy demand managing strategies) will have a marginal impact on the GDP. These findings are in line with those (Abid & Mraihi, 2014; Ahmed et al., 2013; Akinlo, 2008; Altinay & Karagol, 2005; Chen et al., 2007; Cheng, 1997; Chiou-Wei, Chen, & Zhu, 2008; Faisal, TÜRSOY, & REŞATOĞLU, 2017; Huang et al., 2008; Hye & Riaz, 2008; Lee & Chang, 2007; Ozturk et al., 2010; Shahbaz, Tang, & Shabbir, 2011; Wolde-Rufael, 2006; Yasar, 2017; Yoo, 2006). Likewise, on the basis of empirical findings, we conclude that ENC and FD are interdependent means bi-directional causality is present between the ENC and FD in South Asian countries in the short run as well as in the long run. Bi-directional causality means both ENC and FD are complementary to each other. Because development in any economy could never be achieved without both main pillars of the economy e.g., a developed financial system and sufficient energy supply. Few studies support these results in the previous literature (Danish et al., 2018; Faisal et al., 2017; Roubaud & Shahbaz, 2017; Sbia, Shahbaz, & Ozturk, 2017; Shahbaz & Lean, 2012). However, the results of other variables are mixed. In South Asian countries, causality is running from GDP to ENC means the “Conservation Hypothesis” is confirmed. Therefore, these results provide a better understanding to the policymakers and they can formulate the policies relevant to energy on the basis of these results. However, when, GDP leads to ENC then the externality of the energy consumption (ENC) will be set back to the GDP. Hence, in this scenario the conservation policy is necessary. These conservation policies should be environment friendly like demand-side management policies and efficiency improvement measures, whose purpose is to decrease the wastage of energy and would not harmfully impact the economic activities in the long run.

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Conflict of Interests

The authors declare that they have no conflict of interests.

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