Natural resources volatility and South Asian economies: Evaluating the role of COVID-19

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ABSTRACT

Since the emergence of the Covid-19 pandemic, global economic performance has been severely affected, which also causes natural resource price instability. Recently, scholars and policy-makers put more attention towards the global economic performance and natural resource volatility nexus. This study investigates four South Asian economies (Afghanistan, Bangladesh, India, and Pakistan) from 1991 to 2021. Using the (Pesaran, 2007) CIPS unit root test, the study found first differenced stationary data cointegrated as confirmed by the (Westerlund, 2007) cointegration test. However, this study employed the CCEMG approach to identify the association of natural resource volatility and economic performance in the selected region. Empirical results revealed that total natural resource rents, forest rents, and oil prices negatively and significantly affect economic performance. While oil rents, coal rents, and natural gas rents have a significant contribution to the region's economic performance. Results further illustrate a bidirectional causal association between economic performance and other variables except for coal rents, which is unidirectional. Based on the empirical findings, the current study acclaims some practical implications that could potentially reduce the negative influence of natural resources volatility on economic performance.

1. Introduction

The emergence of the contagious Covid-19 pandemic causes a global economic slow-down and fluctuation in the natural resource and their prices. The attention of researchers and policy-makers has greatly been attracted by this new agenda of natural resources volatility and economic performance in the Covid-19. Although numerous studies have been done on the impact of natural resources on economic growth, where some of the studies showed that natural resources are curse (Cheng et al., 2020a; Li et al., 2021; Qiang and Jian, 2020; Rahim et al., 2021; Umar et al., 2020; Yang et al., 2021) and some indicates that natural resources are blessings (Atil et al., 2020; Redmond and Nasir, 2020; Su et al., 2020a). However, empirical evidence provided by the scholars argued that natural resource abundance could be the primary reason for lagging economic growth and performance than the natural resources scarce economies (Gylfason and Zoega, 2006; Sachs and Warner, 2001). However, the role of natural resources in economic growth and performance has been widely investigated. On the other hand, natural resources price volatility is also an important indicator of industrial production and economic activities – it determines the country's economic performance or region. Based on the simple demand and supply theory, the price hike of natural resources could reduce its demand and vice versa. As per (Kilian, 2008), an increase in the natural resources (oil prices) in oil-exporting economies increases stock prices and shares due to oil export revenues. However, this could also adversely affect the stock market participation in the oil-importing economies, but the outcomes are mixed and contradictory (Narayan and Narayan, 2010; Silvapulle et al., 2017; Su et al., 2020b; Umar et al., 2021a, 2021c; Wang et al., 2021). Nonetheless, the oil price volatility the literature provides evidence regarding the influential role of oil prices and oil price volatility on various economic and financial indicators. Yet, there is limited literature regarding the nexus of natural resources volatility and economic performance, which is a burning issue in recent times. Therefore, this enriches the existing literature and

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attracts scholarly attention to this persistent issue.

Oil prices play a significant role in every economy's market and economic performance, among other natural resources. On the one hand, a reduction in oil prices consequently diminishes production costs, enhancing economic growth in the country (Narayan et al., 2014; Song et al., 2020). As a result, the stock prices increase due to higher expected revenue and earnings in the future (Filis, 2010; Sadorsky, 1999; Umar et al., 2021b). While on the other hand, an increase in the oil prices reduced its demand, which declined industrial production due to high production costs. Also, this leads to the declination of the shareholders' future expected revenue and earnings, which causes postponement of investment and leads the economy to an uncertain situation. Recently, a decline has been observed in the oil prices and other natural resources due to the Covid-19 pandemic, which adversely affects the energy importing and exporting economies across the globe. The covid-19 pandemic has severely disrupted the global supply chains and reduced aggregate demand, which hit developing nations such as South Asian economies the most (Gao et al., 2021; Vidya and Prabheesh, 2020; Wang et al., 2021). Specifically, this disastrous influence of the Covid-19 pandemic causes a sharp deterioration of crude oil in the international market from US\$ 58 on January 15, 2020, to US\$ 20 on April 15, 2020. Since this decline in oil prices causes deterioration to the natural resources market and disturbs economic growth by affecting the region's economic performance. Therefore, the issue requires an immediate empirical investigation.

The primary objective of this study is to empirically analyze the influence of natural resources volatility on the economic performance of the South Asian economies. As Covid-19 has created a global economic recession that offset industrial activities and enhanced volatility in natural resources. Therefore, it is important to analyze the influence of such natural resource volatility to address this burning issue in developing economies. Nonetheless, attempts have been made to associate natural resources commodity price volatility with economic performance (Ma et al., 2021; Sun and Wang, 2021). Still, these studies focused on the Covid-19 pandemic period while ignoring the earlier periods. Secondly, this study considered the role of natural resources rents such as forest rents, coal rents, and oil rents to empirically analyze their impact on the economic performance of developing countries in South Asia. More interestingly, most of the studies have covered developed nations for empirical evidence. However, developing countries are the ones that are worst affected due to lower growth rates and higher unemployment. The lack of literature for developing nations encourages this study to empirically analyze whether these rents are the factors of economic performance. Lastly, this study aims to analyze the impact of oil prices on the economic performance of these developing nations. As earlier studies have empirically investigated the impact of oil prices on economic growth, the stock market, and other economic and financial indicators. Still, these studies provide mixed findings, and also, the studies lack the inclusion of the Covid-19 pandemic, which needs further empirical evidence.

In response to the prior, this study will help provide new empirical insights that could help modify or make policies that will help maintain sustainable economic growth. Specifically, the paper suggests price friezing or price ceiling policies for reducing natural resources volatility, which will encourage investors and industries to expand the industrial and economic sectors, leading to enhancement of economic performance in the study region. Also, natural resources hedging could be an appropriate risk management policy to reduce natural resources volatility. Moreover, natural resources rents such as coal rents, oil rents, and natural gas rents help enhance the region's economic performance. Still, policies must consider the efficient utilization of natural resources while tackling natural resources exploitation. Since the Covid-19 pandemic is also a factor of natural resources volatility, policies must be strengthened regarding vaccination for the earlier recovery of economic performance and minimizing volatility in the natural resources market.

This study contributes to the existing literature by threefold: Firstly,

it is among the first studies to empirically examine the association of natural resources volatility and economic performance. Since the existing literature provides evidence regarding the causal association of natural resources volatility and economic performance (Ma et al., 2021; Sun and Wang, 2021). Still, the exact influence of natural resources volatility remained unexplored, which this study provided via employing the CCEMG approach. Secondly, this attempt is an addition to the mixed findings regarding the connection of natural resources volatility and economic performance by providing empirical evidence based on the recent data. Lastly, the current study analyzes the extended dataset by including the period of the Covid-19 pandemic, which is relatively less explored in terms of natural resources volatility and economic performance.

The organization of the paper is as follows: Section-2 represents relevant literature review of the existing studies that cover all the study variables; Section-3 provides data, models, and methodological setup for an empirical investigation of the data; Section-4 provides empirical results and their discussion, and Section-5 represents concluding remarks and some practical policy implication based on the empirical findings of the research study.

2. Literature review

Scholars and policy-makers have provided extensive literature regarding the association between natural resources and economic growth/development. However, the literature is relatively less extensive concerning the recent trend of natural resource volatility in prices. However, the available literature is provided and discussed in detail.

(Hayat and Tahir, 2021) analyzed volatility in natural resources and economic growth in the resource-rich economies over the period from 1970 to 2016. The study used the autoregressive distributed lags model (ARDL) and concluded that natural resources positively and significantly affect economic growth in the region. However, volatility in natural resources significantly and adversely affects economic performance in resource-rich economies. In addition, the recent study of (Ma et al., 2021) examined the causal association of natural resources commodity price volatility and economic performance in the case of China. The study employed the novel wavelet approach and concluded that natural resources are volatile. Also, the study demonstrates that there is a two-way causal association exists between the said variables. In contrast (Sun and Wang, 2021), used a similar estimating approach and revealed no causal association among the variables. However, the studies of (Ma et al., 2021) and (Sun and Wang, 2021) validate that natural resources commodity prices are more volatile during the Covid-19 pandemic. Regarding the specific influence of natural resources price volatility on economic performance (Wen et al., 2021), uses CS-ARDL and AMG estimator and conclude that natural resources volatility and the natural gas rents and oil rents significantly promote economic growth performance in the BRICS economies.

Concerning the influence of natural resources on economic growth (Erdoğan et al., 2020), investigated Next-11 countries between the 1996–2016 period and revealed that financial deepening acts as a regulator for the positive influence of natural resources on economic growth. In the same vein (Redmond and Nasir, 2020), demonstrate that natural resource abundance, institutional quality, and trade openness promote the economic growth panel of 30 countries between the 1990–2016 period. On the other hand (Rahim et al., 2021), demonstrate that natural resources negatively affect economic growth in the Next-11 countries, while natural resources and human capital could promote the region's economic performance. In natural-resource-dependent economies (Guan et al., 2021), investigated the influence of natural resource price volatility on economic growth between 2000 and 2020. The study utilized pooled mean group (PMG) and ARDL approaches and revealed that the oil market had suffered more than the gold market in the last two decades. However, volatility in both gold and oil prices adversely affects the region's economic performance, specifically in the long run.

In addition to the influence of natural resources on economic performance, studies have provided mixed evidence where some authors found a positive impact on economic growth and reveal that natural resources are blessings for the economy. While others found a negative association of natural resources and economic growth that argued natural resources are a curse for the economy. In this regard (Atil et al., 2020), investigated Pakistan over the period from 1972 to 2017. Estimated results reveal that natural resources and oil prices are blessings for financial development in the country. However, economic globalization impedes economic performance in the study region. in the same vein (Ampofo et al., 2020), analyzed the influence of natural resource rents on the economic growth of the top ten mineral-rich economies throughout 1981 2017. The study found a non-linear cointegration relationship between natural resource rents and economic growth. Also, the estimated results illustrate that natural resources showed mixed effects for various countries: that is, natural resource rents are blessing for Brazil and Canada, while curse for Australia, India, DRC, and Saudi Arabia. Regarding the negative influence of natural resources on economic growth (Qiang and Jian, 2020), validate that natural resources are a curse to China's economic growth and development. At the same time, these findings are validated by (Cheng et al., 2020b) by arguing that natural resources adversely affect green economic growth due to the dependence of the resource industry in China. In continuation (Frynas and Buur, 2020), confirm that natural resources are a curse to economic growth in African economies. On the other hand (Zeeshan et al., 2021), used the structural equation modeling technique for Latin America and provided evidence that natural resources positively influence economic growth in the region, thus validating natural resources as blessings (Shao and Yang, 2014). illustrate that natural resources could act as blessings unless the institutional quality and education are not performing to the quality level. In the case of (Mohamed, 2020), the vector error correction approach was used between the 1970–2015 period and revealed that natural resources are blessings to economic growth. However, these natural resources negatively affect education level and health in the study region.

Literature regarding the influence of oil price volatility on economic growth is extensively provided for various countries and regions. Such that (CHIEN et al., 2021) uncovered this association in Pakistan over the period from 1980 to 2018. Estimated results revealed that oil price volatility negatively and significantly affects the individual and aggregate level economy. However, the only positive impact of oil price volatility is on the transport and communication sectors. However, many indicators determine oil price volatility. In this regard (Gong et al., 2020), identified that total export-import volume, inflation, and economic growth have a significant negative effect on the volatility of oil prices. That is, these indicators reduce oil price volatility. However, the significant contributor to oil price volatility is the exchange rate. Using a non-linear ARDL approach (Akinsola and Odhiambo, 2020), reveal that oil prices' short-run influence on economic growth is mixed for low-income oil-importing economies. However, the long-run influence of oil prices is negative and significant in the region. Besides, the volatility does not only have a significant influence on economic growth (Hau et al., 2020). unveil that volatility in the crude oil market prices significantly causes volatility in the agriculture commodity futures of China. Regarding environmental degradation, the recent study of (Mohamed, 2020) illustrates that an increase in oil prices reduces environmental degradation in the oil-importing economies due to a reduction in oil demand and economic and industrial activities. However, this increase in oil prices positively affects environmental degradation in the oil-exporting economies. Moreover (Baba, 2020), used vector autoregressive (VAR) and Granger causality approaches and illustrates that oil price volatility enhances poverty in Nigeria and reduces household welfare. The study also provides evidence that oil price volatility negatively influences economic growth in the region. Besides, the authors confirmed the bidirectional causal association between oil prices and economic growth.

The study (Canh et al., 2020) analyzed the natural resource rents and economic complexity nexus in 90 developed and developing economies throughout 2002–2017. The study found that economic complexity significantly influences natural gas rents, mineral rents, and coal rents. Concerning the specific influence of coal consumption on economic growth (Udi et al., 2020), investigated South Africa between 1970 and 2018. Using the ARDL bound testing approach, the study concludes that coal consumption negatively and significantly influences economic growth in both the short- and long-run. In addition (Joshua and Bekun, 2020), revealed that there is a bidirectional causal association between coal and consumption and economic expansion (Y. Huang et al., 2020). investigated 25 Asian Developing economies over the 1996–2016 period and used the PMG estimator. The examined results reveal that forest rents are playing a substantial and positive role in the economic growth of the study region. In contrast (Bhatia and Cumming, 2020), found no clear relationship between forest rents and economic growth in 23 Island nations. In addition to the prior literature (Etokakpan et al., 2020), and (Galadima and Aminu, 2020) found that natural gas consumption has a significant and mediating contribution to Malaysia and Nigeria's economic growth, respectively.

3. Methodology

3.1. Data and model specification

Based on the study objectives and the existing literature as provided in Section-2, this study adopted a total of seven variables. The dependent variable is economic performance, which is proxied by the gross domestic product (GDP). The existing literature and economic theories suggested that GDP measures the economy's health, which considers most macroeconomic variables such as aggregate consumption, aggregate expenditure, aggregate investment (Li et al., 2021). Therefore, considering GDP as a proxy for the economic performance of a country or region could provide an in-depth investigation of the economy. The remaining six variables are considered explanatory variables, including total natural resources rent (TNR) that captures natural resources volatility. Since volatility in natural resources may affect the region's economic performance by various channels, including the investment postponement and high cost of capital accumulation for industrialists. Also, the Covid-19 pandemic creates uncertainty in the natural resources market currently. Hence, following the studies of (Sun and Wang, 2021; Wen et al., 2021), and (Ma et al., 2021), this study investigated natural resources volatility and economic performance by adopting the following controlled variables as oil rent (ORR), coal rent (CRR), forest rent (FR), natural gas rent (NGR), and oil prices (OP). Since these variables represent the extensive part of natural resources rents and substantially contribute to economic growth (Hayat and Tahir, 2021). Therefore, it is important to investigate these variables in terms of economic performance in developing nations. These variables have been obtained from two sources, i.e., World Development Indicators (Bank, 2019) and Crude Oil WTI (2021). For all the mentioned variables, the data covers the period from 1991 to 2021, considering the pre and post Covid-19 pandemic for four South Asian economies: Afghanistan, Bangladesh, India, and Pakistan. Variables' descriptions and data sources are provided in Table 1. Additionally, the data for OP is converted to the local currencies of each country.

This study constructed three models based on the objectives and variables under consideration. The reason for selecting three models is to aim for the robustness of each model, what is analysis, and specifically examine the variable from specific to general approach. The first constructed model is provided as follows:

Model-1

$$GDP_{it} = f(TNR_{it}, ORR_{it}, CRR_{it}, FR_{it})$$

Model-1 reveals that economic performance is the function of total natural resource rents, oil rents, coal rents, and forest rents across the

Table-1

Variables description and data source.

Variable	Description	Data Source
GDP	Gross domestic product, measured in constant US$ 2010 prices	https://databank.worldbank.org/source/world-development-indicators#advancedDownloadOptions
TNR	The sum of oil rents, natural gas rents, coal rents (hard and soft), mineral rents, and forest rents and measured as a percent of GDP.	https://databank.worldbank.org/source/world-development-indicators#advancedDownloadOptions
ORR	The difference between the value of crude oil production at regional prices and total costs of production and measured as a percent of GDP.	https://databank.worldbank.org/source/world-development-indicators#advancedDownloadOptions
CRR	The difference between the value of both hard and soft coal production at world prices and their total costs of production and measured as a percent of GDP.	https://databank.worldbank.org/source/world-development-indicators#advancedDownloadOptions
FR	Roundwood harvest times the product of regional prices and a regional rental rate and is measured as a percent of GDP.	https://databank.worldbank.org/source/world-development-indicators#advancedDownloadOptions
NGR	The difference between the value of natural gas production at regional prices and total costs of production and measured as a percent of GDP.	https://databank.worldbank.org/source/world-development-indicators#advancedDownloadOptions
OP	The spot price of one barrel of the benchmark crude oil	https://www.investing.com/commodities/crude-oil-historical-data

panel.

Model-2

$$GDP_{it} = f(TNR_{it},\ ORR_{it}, CRR_{it}, FR_{it}, NGR_{it})$$

Model-2 demonstrates that economic performance is the function of variables including in Model-1 and natural gas rents.

Model-3

$$GDP_{it} = f(TNR_{it},\ ORR_{it}, CRR_{it}, FR_{it}, NGR_{it}, OP_{it})$$

Model-3 demonstrates that economic performance is the function of variables including in the Model-2 and oil prices in the selected region. These generally constructed models could be transformed into the regression models as following Eq. (1), Eq. (2), and Eq. (3):

$$GDP_{it} = \theta_0 + \theta_1 TNR_{it} + \theta_2 ORR_{it} + \theta_3 CRR_{it} + \theta_4 FR_{it} + \varepsilon_{it} \quad (1)$$

$$GDP_{it} = \theta_0 + \theta_1 TNR_{it} + \theta_2 ORR_{it} + \theta_3 CRR_{it} + \theta_4 FR_{it} + \theta_5 NGR_{it} + \varepsilon_{it} \quad (2)$$

$$GDP_{it} = \theta_0 + \theta_1 TNR_{it} + \theta_2 ORR_{it} + \theta_3 CRR_{it} + \theta_4 FR_{it} + \theta_5 NGR_{it} + \theta_6 OP_{it} + \varepsilon_{it} \quad (3)$$

Where in the above equations, GDP_{it} is the economic performance of the selected panel economies, TNR_{it} denoted total natural resource rents, ORR_{it} indicate oil rents, CRR_{it} represents coal rents, FR_{it} is mentioned for the forest rents, NGR_{it} denotes natural gas rents, and OP_{it} Indicates oil prices of the selected four South Asian economies. Besides, $\theta_1, \theta_2, \theta_3, \theta_4, \theta_5,$ and θ_6 are the coefficients of TNR, ORR, CRR, FR, NGR, and OP, respectively. Additionally, θ_0 and ε_{it} are the intercept and error terms, respectively. Moreover, "*i*" and "*t*" in the subscript of each variable denotes cross-section and time-series, respectively.

3.2. Estimation strategy

Once the models are specified for an empirical investigation. We then utilized various econometric strategies to analyze each exogenous variable's influence on economic performance. However, prior to that,

some pre-requisites demonstrate selecting appropriate econometric technique(s). Therefore, it is important to examine the slope coefficient heterogeneity, cross-section dependence, unit root or stationarity testing, cointegration test, and the final selection of the appropriate and efficient estimator. Finally, the causal association between the variables under study.

3.2.1. Panel cross-section dependence

This section of estimation strategy is started by testing the cross-section dependence of the selected study panel. Countries worldwide depend upon each other partially or wholly for various financial, economic, and/or environmental objectives. However, this dependence across countries shows similarities and dissimilarities in some respect. The issue of the cross-section is more familiar in the panel data having both time series and cross-sections while ignoring these cross-section dependence issues provides biased and inconsistent estimates (Campello et al., 2019; Le and Bao, 2020). Therefore, the current study used the (Pesaran, 2004) cross-section dependence (CD) test to avoid biased estimates. The statistics estimates of the (Pesaran, 2004) CD test are more efficient than the Breusch-Pagan LM test as they might provide inconsistent results (Le and Bao, 2020). The estimating process of the Pesaran CD test is presented as follows:

$$CD_{Test} = \frac{(2T)^{1/2}}{\sqrt{N(N-1)}} \sum_{i=1}^{N-1} \sum_{k=1+i}^{N} \frac{T - k\rho_{ik}^2 - E[(T-k)\rho_{ik}^2]}{var[(T-k)\rho_{ik}^2]} \quad (4)$$

Where in the above Eq. (4) the sample size is denoted by N, time period is represented by T, ρ_{ik}^2 indicates the pair-wise correlation coefficients obtained from the ordinary least square (OLS) estimation for the dimension of each cross-section (*i*). The (Pesaran, 2004) CD test assumed cross-section independence as the null hypothesis. However, the assumption of no cross-section dependence could be rejected if the estimates found are significant.

3.2.2. Slope heterogeneity

Once the cross-section dependence of the panel is analyzed, we further examine the slope coefficient heterogeneity of the panel. In an econometric examination of the panel data, it is important to consider the slopes and coefficients heterogenous. If the slopes are assumed as homogenous, it may provide untrustworthy and misleading results if the data possesses heterogeneous characteristics (Breitung, 2001). In this regard (Pesaran and Yamagata, 2008), developed (Swamy, 1970) method to test the phenomenon of slope homogeneity described as follows:

$$\widehat{\Delta}_{SCH} = \sqrt{\frac{N}{2k}} (N^{-1}\acute{S} - K) \quad (5)$$

$$\widehat{\Delta}_{ASCH} = \sqrt{\frac{N}{2k}} \sqrt{\frac{T+1}{(T-K-1)}} (N^{-1}\acute{S} - 2K) \quad (6)$$

$$S = \sum_{i=1}^{N} (\widehat{\gamma}_i - \widetilde{\gamma}_{WFE}) \frac{\acute{X}_i M_\tau X_i}{\widetilde{\sigma}_i^2} (\widehat{\gamma}_i - \widetilde{\gamma}_{WFE}) \quad (7)$$

Where $\widehat{\Delta}_{SCH}$ calculates the slope coefficient heterogeneity and $\widehat{\Delta}_{ASCH}$ estimates the adjusted slope coefficient heterogeneity across the panel. $\widehat{\gamma}_i$ denotes the coefficient for pooled OLS of each individual cross-section ranging from 1 to N and $\widetilde{\gamma}_{WFE}$ indicates the weighted fixed effect (WFE) pooled estimator. Moreover, $M_\tau, \widetilde{\sigma}_i^2$ And K represents the identity matrix, an estimate of variance, and the independent variables' number, respectively. In addition, the Pesaran and Yamagata (2008) SCH test assume that the slopes coefficients are homogenous across the panel. However, if found significant, the significant estimates would lead to reject the null and conclude that the slopes are heterogeneous.

3.2.3. Panel stationarity testing

Once the cross-section dependence and slope heterogeneity are tested. It will allow us to use the first generation or second generation unit root test. The first generation panel unit root tests such as augmented Dickey-Fuller (ADF), Im-Pesaran-Shin (IPS), Levin-Lin Chu (LLC), and Phillips-Perron (PP) tests provide invalid estimates (Pesaran, 2007). In this regard (Pesaran, 2007), proposed a second-generation unit root test that considers cross-sectionally ADF (CADF) and the cross-sectionally augmented IPS (CIPS), which provides valid and efficient estimates while considering the cross-section dependence in the panel. to avoid the issue of cross-section dependence, this approach modified the ADF regression with the lagged cross-sectional mean and its first difference [I(1)]. This approach is efficient even if the cross-sections are greater than the time period or vice versa, i.e., N > T and T > N in analysis. The CADF regression is presented in general form as follows:

$$\Delta y_{i,t} = \theta_i + \beta_i^* y_{i,t-1} + d_0 \bar{y}_{t-1} + d_1 \Delta \bar{y}_t + \varepsilon_{it} \tag{8}$$

Where $\bar{y}_t$ represent the average of total observations (N). For avoiding the serial correlation issue, the regression must include the I(1) lags of both y_{it} and $\bar{y}_t$, which could be estimated as follow:

$$\Delta y_{i,t} = \theta_i + \beta_i^* y_{i,t-1} + d_0 \bar{y}_{t-1} + \sum_{j=0}^{n} d_{j+1} \Delta \bar{y}_{t-j} + \sum_{k=1}^{n} c_k \Delta y_{i,t-k} + \varepsilon_{it} \tag{9}$$

Furthermore, Pesaran (2007) introduced the t-statistics average for each cross-section unit ($CADF_i$) considered in the panel and provides the CIPS results, which could be calculated as follows:

$$CIPS = N^{-1} \sum_{i=1}^{N} CADF_i \tag{10}$$

Moreover, the (Pesaran, 2007) CIPS test assumes that the unit root is present in the data, which could be termed the test's null hypothesis. However, the null could be rejected after CIPS statistics exceed critical or tabulated values.

3.2.4. Panel cointegration testing

After analyzing the slope heterogeneity, cross-section dependence, and testing for stationarity, this study further examines the cointegration relationship among the variables under consideration. However, in the presence of cross-section dependence and slope heterogeneity, we need an efficient cointegration estimator that could tackle both the said problems. In this regard (Westerlund, 2007), introduced a test for panel cointegration which considers both the slope heterogeneity and cross-section dependence issues. The said test is based on the error correction model, which is provided as follows:

$$\Delta y_{i,t} = \theta_i' d_t + \beta_i \left(y_{i,t-1} + \dot{\gamma}_i X_{i,t-1} \right) + \sum_{j=1}^{k} \vartheta_{ij} y_{i,t-j} + \sum_{j=0}^{k} \vartheta_{ij} X_{i,t-j} + \varepsilon_{it} \tag{11}$$

Where in Eq. (11), β_i is the speed of adjustment, which the system adjusts towards equilibrium. (Westerlund, 2007) is developed based on least square estimates of $\hat{\alpha}_i$. The said test assumes no cointegration relationship among the variables. Besides, the said approach is efficient as it provides both the group mean statistics and the panel statistics.

Where the group mean statistics are presented as $G_t = \frac{1}{N} \sum_{i=1}^{N} \frac{\hat{\alpha}_i}{SE\hat{\alpha}_i}$ and $G_a = \frac{1}{N} \sum_{i=1}^{N} \frac{T\hat{\alpha}_i}{\hat{\alpha}_{i(1)}}$. However, if the G_t and G_a are found significant, it means that at least one cross-section is cointegrated. On the other hand, the panel could be obtained from these formulas, i.e., $P_t = \frac{\hat{\alpha}}{SE(\alpha)}$ and $P_a = T\hat{\alpha}$. Where these formulations revealed that if the P_t and P_a are significant, then the whole panel would be cointegrated.

3.2.5. Long-run estimation and panel causality test

After estimating the pre-requisite of panel data, the most crucial part is adopting the right and efficient estimator to identify the true relationship between dependent and independent variables. However, in the presence of cross-section dependence and slope heterogeneity, traditional estimating approaches may provide biased and inconsistent estimates (Le and Bao, 2020). In this regard (Pesaran, 2006), proposed a Common Correlated Effect Mean Group (CCEMG) estimator, which provides robust estimates in the presence of cross-section dependence slope heterogeneity. This approach includes the averages of both dependent and independent variables and considers the common unobserved effects. Generally, the regression form for the CCEMG estimator could be written as presented in Eq. (12) below:

$$y_{i,t} = \theta_i + \beta_i x_{i,t} + \delta_i \bar{y}_{i,t} + \alpha_i \bar{x}_t + c_i f_t + \varepsilon_{it} \tag{12}$$

Where $y_{i,t}$ and $x_{i,t}$ are the dependent and independent variables, respectively; β_i indicates the slope of a specific country; f_t represents heterogenous factors' unobserved common factors and: lastly, θ_i and ε_{it} are the intercept and error term of the regression, respectively.

Since the CCEMG estimator provides the specific influence of each explanatory variable on economic performance, this tested for the robustness of the model in the long run. In this regard, we employed the panel dynamic ordinary least square (DOLS) approach, which is parametric. This approach provides robust results by tackling endogeneity and serial correlation issues. The DOLS could be estimated via the following equation:

$$y_t = X_t' \alpha + D_{1t}' \beta_1 + \sum_{j=-q}^{r} \Delta \acute{X}_{t+j} \sigma + v_{1t,} \tag{14}$$

The DOLS approach covers augmentation of cointegration regression with leads and lags of $\Delta \acute{X}_t$ for making cointegration equation error term orthogonal. Regarding the assumption of including r leads and q lags of the differenced regressors absorb the long-run correlation among e_{1t} and e_{2t}.

Once the specific influence of each exogenous variable is identified on the economic performance of the selected countries, we further investigated for the causal association between these variables. Thus, the current study employed (Dumitrescu and Hurlin, 2012). The reason for adopting this approach is that it provides efficient estimates when the panel is unbalanced, i.e., the time series and cross-sections are not equal (T≠N). In addition, this test provides unbiased estimates as it deals with slope heterogeneity and cross-section dependency (Banday and Aneja, 2020).

4. Results and discussion

This study begins the section of empirical estimation by analyzing the panel's slope coefficient heterogeneity and cross-section dependence. As mentioned earlier in Section-3 that countries across the globe depends on other countries for various motives. It includes economic, financial, trade, and environmental objectives that lead these economies to depend on other countries or regions. The dependence of one country over other countries exhibits similarities and differences to the one they linked. However, it is important to identify both issues because ignoring slope heterogeneity and cross-section dependence in a panel data analysis provides biased and misleading estimates (Breitung, 2005; Campello et al., 2019, 2019, 2019; Le and Bao, 2020). In this regard, we employed the (Pesaran and Yamagata, 2008) SCH test, and its outcomes are presented in Table 2. This test provided SCH and adjusted SCH (ASCH) estimation while assuming that the slopes coefficients are homogenous across the panel. The estimated results uncover that both SCH and ASCH are highly statistically significant for all the three models at all 1%, 5%, and 10% levels. These significant estimates (Pesaran and Yamagata, 2008) thus reject the null hypothesis of homogeneous slopes and conclude that the slope coefficients are heterogeneous across

Table-2
Slope coefficient heterogeneity.

Slope Heterogeneity Test	Model-1	Model-2	Model-3
$\tilde{\Delta}$	9.615***	6.161***	6.851***
$\tilde{\Delta}^{Adjusted}$	10.707***	7.002***	7.954***
Cross-Section Dependence			
GDP	**TNR**	**ORR**	
13.385***	7.475***	12.702***	
CRR	**FR**	**NGR**	
9.32***	3.058***	13.434***	
OP			
12.127***			

Note: Significance level is denoted by ***, ** and * for 1%, 5% and 10%.

selected panel countries. Besides, the cross-section dependence has also been investigated for the data and variables under consideration. In this regard, we used the (Pesaran, 2004) CD test, and the estimated outcomes are provided in the same Table 2. These outcomes display highly statistically significant results for all the variables under consideration at 1%, 5%, and 10% levels. Therefore, the null hypothesis of no cross-section dependence could be rejected. The results then conclude that GDP, TNR, ORR, CRR, FR, NGR, and OP are cross-sectionally dependent. The results of slope heterogeneity and cross-section dependence allow the current study to use the second generation unit root test, which tackles slope heterogeneity and cross-sectional dependence issues in the selected panel.

Once the slopes heterogeneity and cross-section dependence are investigated, this study analyzes the data's stationarity over time. The stationarity of data plays a substantial role in an empirical examination of the data, whether time-series or panel. Ignoring stationarity testing in an econometric analysis cloud leads to inefficient estimates. Therefore, this study utilized the Pesaran (2007) CIPS unit root test. The estimated results of the said test id provided in Table 3. As mentioned in the table, the (Pesaran, 2007) CIPS unit root test provides estimated results on both the leveled data and the first differenced data. These results indicate that all the variables are found insignificant at I(0), which leads to accepting the null hypothesis that the unit root is present in the data in the selected time span. While on the other hand, the I(1) results revealed that all the variables showed significant estimates at 1%, 5%, and 10% levels, which leads to the rejection of the null hypothesis that the unit root is present in data across time. Hence, it is concluded that the data on the first difference is stationary for GDP, TNR, ORR, CRR, FR, NGR, and OP, which allows us to investigate the cointegration association between these variables.

After analyzing for the stationarity, the results obtained unveil that the data is stationary at I(1), which allows us to investigate the cointegration relationship of variables. In this regard, we utilized the (Westerlund, 2007) cointegration test. Estimated outcomes of the said test are provided in Table 4. The (Westerlund, 2007) cointegration test is an efficient estimator as it tackles both cross-section dependence and slope heterogeneity issues. Besides, this approach provides both the group

Table-3
Unit root testing (Pesaran, 2007).

Variables	Intercept and Trend	
	I(0)	I(1)
GDP	−2.709	−5.409***
TNR	−2.285	−5.342***
ORR	−2.063	−5.261***
CRR	−1.692	−4.224***
FR	−1.281	−4.421***
NGR	−1.881	−4.442***
OP	−0.100	−5.274***

Note: Significance level is denoted by ***, ** and * for 1%, 5% and 10%. While I(0) is of level, and I(1) is for the first difference.

Table-4
Cointegration results (Westerlund-2007).

Statistics	Model-1	Model-2	Model-3
G_t	−5.985***	−5.985***	−4.9e+04***
G_a	−16.755***	−16.755***	−15.096***
P_t	−8.346***	−8.346***	−9.373***
P_a	−12.261**	−12.261***	−15.132***

Note: Significance level is denoted by ***, ** and * for 1%, 5% and 10%.

mean statistics and the panel statistics, which analyze the cointegration in each cross-section and among the panel separately. This test assumes that the ECM is equal to zero in a conditional panel ECM. Particularly, the test assumes no cointegration relationship among the cross-section and the panel as the null hypothesis. However, the estimated results reveal that both the group (G_t, G_a) and the panel (P_t, P_a) statistics are highly statistically significant at 1%, 5%, and 10% levels. Therefore, the null hypothesis of no cointegration could be rejected as the ECM is not equal to zero. Hence, it is concluded that the long-run relationship exists between GDP, TNR, ORR, CRR, FR, NGR, and OP. this cointegration relationship allows the current study to empirically analyze the specific influence of each exogenous variable on the economic performance of the selected South Asian economies.

Once the cointegration relationship has been finalized, this allows us to use an efficient estimator for the specific impact of each explanatory variable on the economic performance of the selected panel economies. In this regard, we utilized the CCEMG estimating approach, and the results are provided in Table 5. We have constructed three models based on the study's objectives, for which the results obtained are found highly statistically significant. Specifically, Model-1 reveals that TNR and FR negatively affect economic performance, while ORR and CRR positively affect the economic performance of the selected countries. A one percent increase in the TNR and FR reduces economic performance in the region by 0.300 and 0.042%, respectively. The results are found highly statistically significant at the 1% level and are consistent with the earlier findings of (Guan et al., 2021; Rahim et al., 2021), which empirically identified the negative relationship of natural resources volatility and economic performance. More broadly, enhancement in the volatility of natural resources offset economic performance mainly due to two reasons: Firstly, higher volatility or uncertainty in natural resources restrict investors from investing in the natural resources market due to uncertainty regarding future benefits. Secondly, the manufacturers or industrialists are hesitant to produce or expand their activities due to the higher cost of capital accumulation. Besides, the results of forest rents, which negatively influence economic performance, are found contrary to the study of (Y. Huang et al., 2020), which identifies its positive influence, and (Bhatia and Cumming, 2020), which revealed no clear relationship among forest rents and economic performance. Moreover, ORR and CRR reveal that a one percent increase in these variables promotes economic performance by 0.344 and 0.416%, respectively. These outcomes are found consistent with the earlier empirical estimates of (Ampofo et al., 2021; Atil et al., 2020; Joshua and Bekun, 2020), which illustrates the natural resources (oil rents and coal rents) are the

Table-5
Common correlated effect mean group (CCEMG) results.

Variables	Coefficients [z − statistics]	Coefficients [z − statistics]	Coefficients [z − statistics]
TNR	−0.300*** [-6.38]	−0.140*** [-5.21]	−0.129*** [-4.53]
ORR	0.344*** [4.41]	0.113** [2.17]	0.118*** [2.98]
CRR	0.416*** [4.03]	0.193*** [3.47]	0.150*** [3.56]
FR	−0.042*** [-3.43]	−0.346*** [-4.04]	0.140* [-1.82]
NGR	–	0.359*** [5.92]	0.204*** [4.62]
OP	–	–	−0.0741*** [3.48]
Constant	1.423*** [5.321]	1.401*** [6.452]	1.805*** [4.29]

Note: Significance level is denoted by ***, ** and * for 1%, 5% and 10%.

significant factors of economic growth. Since oil and coal are the primary energy sources across the globe, therefore its contribution is substantial in an economy's growth. Also, the rents of these natural resources are playing an essential role in economic growth by means of enhancement in production and industrial activities, which further contribute to income generation, unemployment reduction, enhancing demand, and improving lifestyle.

Concerning Model-2, the estimated results are provided in the same table. Where the only difference between Model-1 and Model-2 is that the former includes NGR as an exogenous variable. However, the influence of each of the variables from Model-1 remained the same, with a slight difference in the magnitude of the coefficient. That is, a one percent increase in the ORR and CRR significantly increase economic performance by 0.113 and 0.193%, respectively. On the other hand, TNR and FR negatively impact the economic performance, reducing it to 0.140 and 0.346% if these variables increase by one percent, respectively. This model also reveals that natural resources volatility is negatively associated with economic performance, as consistent findings (Hayat and Tahir, 2021). Besides, natural resources, i.e., NGR, are found to positively influence the region's economic performance. specifically, a one percent increase in the NGR causes a rise of 0.359% in economic performance. The results are found highly statistically significant for the Model-2 at 1%, 5%, and 10% levels. Concerning NGR, this study found consistent results to the earlier studies of (Etokakpan et al., 2020) and (Galadima and Aminu, 2020), which demonstrates that natural gas has a significant and mediating contribution to the economic growth of Malaysia and Nigeria, respectively. Like oil and coal, natural gas is also considered an important energy source, which helps run the industrial and transport sectors of the economy.

The estimated results of Model-3 obtained via employing CCEMG are presented in the same Table 5. Where this model includes all the variables from Model-2 and OP as an additional variable. The influence of each exogenous variable is found to have the same relationship with economic performance, but a slight difference is observed in the magnitude of each variable except for the FR. Specifically, a one percent increase in the ORR, CRR, FR, and NGR significantly increase economic performance in the region by 0.118, 0.150, 140, and 0.204%, respectively. However, a one percent increase in the TNR significantly reduces economic performance in the region by 0.129%. These results are found highly statistically significant at 1%, 5%, and 10% levels. Also, the consistent results of the current study with the earlier studies further validate the outcomes (Ampofo et al., 2020; Atil et al., 2020; Bhatia and Cumming, 2020; Etokakpan et al., 2020; Galadima and Aminu, 2020; Y.-S. Huang et al., 2020). However, the final variable, OP, is found to negatively influence the economic performance of the selected countries. To be more specific, a one percent increase in the OP decreases economic performance by 0.0741% at a 1% significance level. The negative influence of OP is also empirically validated by earlier studies such as (Guan et al., 2021), (CHIEN et al., 2021), (Akinsola and Odhiambo, 2020). More broadly, an increase in the natural resource oil prices consequently reduces demand for oil, particularly in the oil-importing economies. The reduced oil demand further adversely affects economic and industrial activities due to high capital accumulation costs for industrialists, consequently reducing production and adversely affecting economic performance in the region.

After obtaining the results of CCEMG, this study employed panel dynamic ordinary least squares for robustness testing of the model. The empirical estimates of panel DOLS are provided in Table 6. The estimated results demonstrate that each explanatory variable's direction of impact remains the same. However, the magnitude of each coefficient value is found to be slightly different. Specifically, natural resources volatility captured by TNR exhibit a negative influence of on the economic performance of the South Asian economies. Also, the variables OP and FR are found to negatively affect economic performance. However, ORR, CRR, and NGR positively impact the region's economic performance in all three models. These estimates are found robust as it verifies

Table-6
Robustness test.

Variables	*Model* − 1 [*Std.Err.*]	*Model* − 2 [*Std.Err.*]	*Model* − 3 [*Std.Err.*]
TNR	−0.157*** [0.040]	−0.047* [0.028]	−0.057** [0.029]
ORR	0.057*** [0.009]	0.023*** [0.006]	0.016** [0.007]
CRR	0.065** [0.030]	0.017 [0.016]	0.016 [0.016]
FR	−0.239*** [0.029]	−0.222*** [0.015]	−0.235*** [0.017]
NGR	–	0.225*** [0.020]	0.221*** [0.020]
OP	–	–	−0.038* [0.020]

Note: Significance level is denoted by ***, ** and * for 1%, 5% and 10%.

the influence of each explanatory variable on economic performance as demonstrated by CCEMG.

Once the specific influence of each exogenous variable is identified, this study further examined the causal association that exists between the variables under consideration. The estimated results of CCEMG provide highly significant estimates, which further allow us to analyze the causal linkage of the exogenous variable with the economic performance of South Asian economies. The current study utilized the (Dumitrescu and Hurlin, 2012). The estimated outcomes of the said test are provided in Table 7. This test assumes that the first variable does not Granger causes the second variable as the null hypothesis. However, the results revealed significant estimates, rejecting the null hypothesis and concluding that Granger's first variable causes the second variable. Specifically, a bidirectional causal relationship exists between exogenous variables such as TNR, ORR, FR, NGR, OP, and the dependent variable GDP (economic performance). This reveals that any policy change in any of these mentioned variables would significantly affect the other. On the other hand, this study also found a unidirectional causal association running from CCR towards economic performance in the selected economies. This demonstrates that any policy change that occurs in the CCR will significantly affect economic performance in the region. However, the policy change that occurs in economic performance will not affect CCR. The findings of (Baba, 2020)which confirm a bidirectional causal association between oil prices and economic performance. At the same time, the empirical results of (Joshua and Bekun, 2020) showed the contrary in the context of a bidirectional causal association between CCR and economic performance. The results obtained either for the unidirectional or bidirectional causal association are highly statistically significant at 1%, 5%, and 10% levels.

5. Conclusion and policy recommendations

5.1. Conclusion

In recent times, scholars and researchers have focused on both natural resources and the economic performance of countries worldwide. After the emergence of Covid-19, the world has faced a new challenge

Table-7
Causality check.

Dumitrescu Hurlin Panel Causality			
H₀	**Wald − Stats**	**Zbar-Stat.**	**p-value**
TNR→GDP	6.12257***	3.29762	0.0010
GDP→TNR	8.90237***	5.62375	0.0000
ORR→GDP	5.64808***	4.22697	0.0000
GDP→ORR	51.0437***	40.8875	0.0000
CRR→GDP	6.66354***	3.75030	0.0002
GDP→CRR	2.65455	0.39558	0.6924
FR→GDP	6.92293***	4.62016	0.0000
GDP→FR	48.2726***	38.5687	0.0000
NGR→GDP	4.99875**	2.35721	0.0184
GDP→NGR	13.7755***	9.70158	0.0000
OP→GDP	6.51744***	4.28085	0.0000
GDP→OP	29.3901***	22.7679	0.0000

Note: Significance level is denoted by ***, ** and * for 1%, 5% and 10%.

regarding economic stabilization as each country across the globe has faced a lockdown environment. After the Covid-19 emergence, the global natural resource market has faced tremendous shocks in market prices after the global financial crisis. This opens the doors for a new debate. In response, this study investigates both the influence of natural resources and natural resources volatility on economic performance in four South Asian economies, including Afghanistan, Bangladesh, India, and Pakistan, over 1991–2021, which considers the covid-19 pandemic period. The estimated result revealed that the I(1) stationary variables are cointegrated. Besides, this study employs the CCEMG estimator, which indicates that natural resources volatility and oil prices are negatively associated with the study region's economic performance. Specifically, natural resource volatility enhancement tends to reduce economic performance by postponing investors from investments and industrialists from further production due to future benefits. In this sense, the level of industrial and financial sectors dropped, which enhanced unemployment and burden on the economy. As a result, economic performance has been adversely affected. On the other hand, oil rents, coal rents, and natural gas rents are positively associated with the region's economic performance. Since the natural resources rents provide an additional benefit to the economy, most of the economic and production sectors are getting advantage of this, consequently leading to the region's enhanced economic performance. The results obtained are robust and consistent with the existing literature. Moreover, the Dumitrescu and Hurlin (2012) Granger panel causality heterogeneous test unveils that the only unidirectional causal relationship is found running from economic performance to CCR. However, the rest of the exogenous variables showed bidirectional causal association with the economic performance in the selected panel economies.

5.2. Policy recommendations

Based on the empirical findings, this study recommends policy implications that could be advantageous the scholars, governors, and policy-makers. Firstly, volatility in total natural resources, forest rents, and oil prices are found adversely associated with economic growth in four South Asian economies. Therefore, policies must be revised regarding regulating natural resources volatility by focusing on balancing the demand and supply of natural resources. Additionally, to control or minimize volatility in natural resources, these economies should implement price ceiling or price freezing policies that will help these countries maintain the prices of natural resources and minimize fluctuation in the prices of natural resources. This will help encourage investors and industrialists to invest and expand the production and economic activities, reduce unemployment, and promote the region's economic performance. In addition, natural resources hedging could play a substantial role in diminishing natural resources volatility. Specifically, this risk management strategy could provide offsetting of losses in investments regarding natural resources. Hence, these countries may benefit from hedging of natural resources for at least in the short-run. Lastly, natural resources rent such as coal rents, oil rents, and natural gas rents although promote economic performance in the South Asian economies. Still, proper attention should be paid to efficiently utilizing these resources while reducing their exploitation. Moreover, strategies for controlling the Covid-19 pandemic must be imposed to stabilize natural resources and reduce volatility. Such policies include compulsory vaccination of each citizen of the nation and following the SOPs.

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