Journal of Social & Organizational Matters
Vol 3 No 2 (2024): 27-42

Quantifying the Impact of Natural Resources on Sustainable Growth in Developing Economies: Evidence from Panel Nonlinear ARDL Technique

Humera Sherazi*[1], Farhat Rasul[2], Nabila Asghar[3]

[1*]Assistant Professor, Department of Management Sciences, Lahore Garrison University, Lahore, Punjab, Pakistan. & Ph.D. (Eco.) Scholar, Department of Economics and statistics, University of Management and Technology, Lahore, Punjab, Pakistan.

[2]Assistant Professor, Department of Economics and statistics, University of Management and Technology, Lahore, Punjab, Pakistan.

[3]Associate Professor, Department of Economics, Division of Management and Administrative Science, University of Education, Lahore, Punjab, Pakistan.

Corresponding author: humera@lgu.edu.pk

Keywords: *Natural Resources Curse, Sustainable Growth, Financial Openness, International Trade*

DOI No: https://doi.org/10.56976/jsom.v3i2.54

The main intention of present research is to examine the effect of natural resource exploration on sustainable growth in developing economies. Annual panel data of 57 developing countries from 2000 to 2021 has been used for research analysis. First, present research uses a simple Panel Autoregressive Distributive Lag (ARDL) estimation technique to analyze the long-run and short-run link between the variables. The outcomes depict that in the long run natural resource exploration has a significant negative impact on sustainable growth. This finding supports the existence of the resource curse hypothesis. Besides this, the present study decomposes the policy variable (mining contribution index) into its two shocks i.e. positive shock and negative shock by using a panel non-linear ARDL approach. The long-run results show that both the coefficients of partial positive and partial negative sums of natural resource rents are negative and substantial. Furthermore, the research outcomes explain that financial openness and international trade have a substantial and positive impact on sustainable progress. The policy suggestions for the present study are to overcome bad rent-seeking manners and to avoid non-productive behaviors to attain sustainable development. Furthermore, there is a dire need to adopt and support environmentally friendly policies.

1. Introduction

The exploration and efficient utilization of natural resources is essential. The traditional resource-based economic growth theory supports that resource endowment has been considered an important element in attaining sustainable progress. Natural resources and economic prosperity have continuously been a topic of great concern around the globe as they provide the basis for human life Tiba, S., 2019. Natural resources have also been emphasized by the SDGs for the attainment of sustainable economic development. (Savoia, 2021).

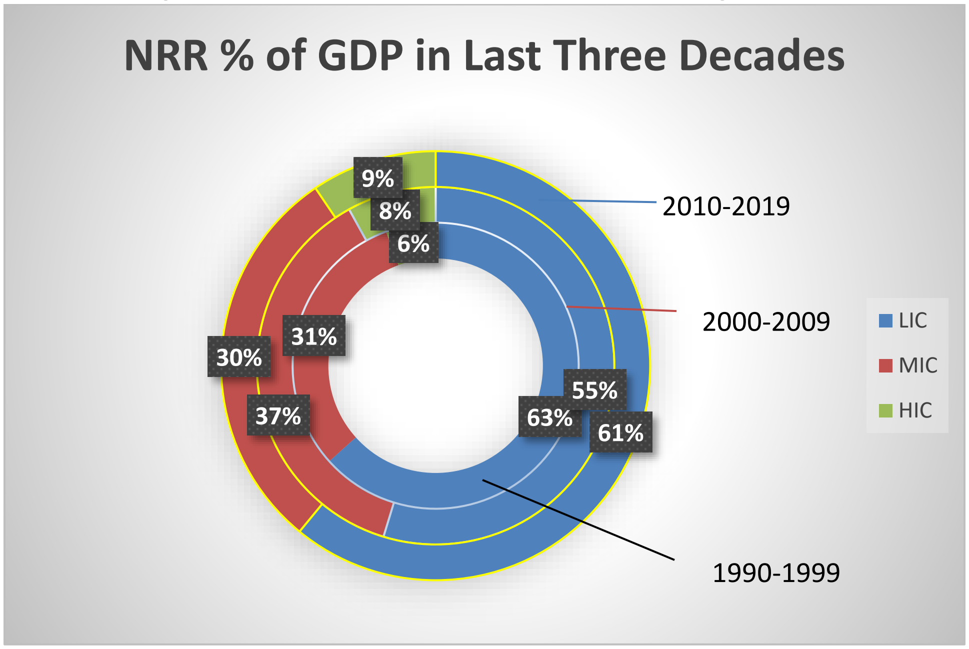
Some renowned development economists, such as Cheang and Palmer (2023), Rostow (1959) and Nurkse (1953), highlighted that natural resources lead to enhanced sustainable growth. This view explains resource-abundant economy is more efficient than a resource-poor economy. On the other side, many economies often fail to enjoy the economic benefits of the available natural resources. It is recognized as the theory of resources curse. This instructs that the economies rich in resources show poor growth while the resource-poor economies mostly perform better. In existing literature many studies support the resource curse hypothesis such as Sachs and Warner (1995, 2001); James and Aadland (2011) and Sharma and Pal (2021).

The figure given below represents the natural resource rents as a percent of gross domestic product in the previous three decades in low-income (LIC), middle-income (MIC), and high-income countries (HIC). The figure explains that although low-income economies have a large share of natural resources due to rent-seeking behavior, corruption, unproductive investment decisions, and poor institutions these countries often perform poorly. For example, some resource abundant countries such as Angola, Nigeria, Venezuela, Sierra Leone and Zambia are all growth losers. Several studies (Asif et al., 2020; Khan et al., 2022) explained that economies having masses of natural resources develop at a lingering velocity than those having reduced natural resources. Contrastingly, economies like Hong Kong, Japan, Singapore, South Korea, Switzerland, Taiwan and which practiced speedy progress during the same period, managed to achieve this success despite having relatively scarce resources. The primary reasons behind their faster development include efficient utilization of limited resources, strong governance, and effective institutional policies. These factors contributed to their economic growth and overall well-being.

In existing literature many studies support the resource abundance hypothesis such as James and Aadland (2011), Muhammad et al., (2021), Leng et al. (2024), Liu et al., (2024). This indicates that a detailed empirical analysis is essential and becomes needed of the present era to assess impact of natural resource exploration in accelerating sustainable growth.

Contribution of present research in available literature is manifold and through different channels. The novelty of the present study is to introduce a new and more comprehensive policy variable in the form of mining contribution index.

Figure No 1: Natural Resource Rents as a Percentage of GDP



Source: Author's calculations data taken from World Development Indicators (2022)

Furthermore, it decomposes the policy variables into positive and negative shocks to get more detailed and comprehensive impact of natural resources exploration on sustainable growth in developing economies. This research emphasizes the role of labor and capital by supporting endogenous growth theory. This study uses the most recent technique and provides an in-depth empirical analysis to confirm the presence of resource curse hypothesis in developing economies. Present research incorporates financial openness in the model and validates the existence of pollution heaven hypothesis in poor economies. In a nutshell this research plays a substantial role in available literature.

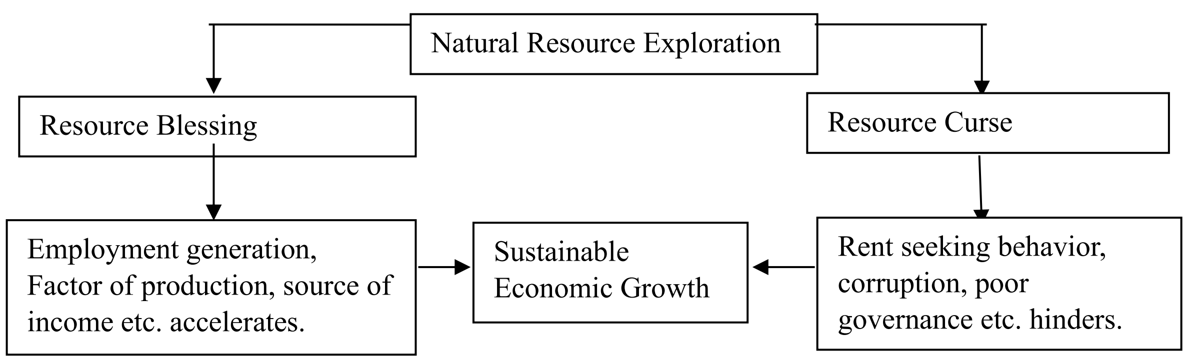
2. Review of literature

In available literature several studies highlighted the presence or absence of resource abundance phenomenon in particular economies by adopting numerous econometric techniques. According to Auty, 2001 the resource deficient economies show three times better growth performance as compared to resource abundant economies. Neumayer (2006) analyzed that because of investment and openness, the excess of natural resources hampers growth. Papyrakis and Gerlagh (2011) incorporated schooling, corruption, trade liberalization, and investment in their augmented growth function and strengthened the presence of the theory of resource curse for the U.S. during 1986-2001. Asekunowo and Olaiya (2012) analyzed the long-run bond amongst oil revenues and growth concerning Nigeria. They support the presence of resource curse because of macroeconomic issues such as weak institutions, and inefficient resource utilization. Elhannani et al. (2016) analyzed that the instability of oil prices along with oil endowment results in slow economic growth instead of accelerating it. Shaw (2013) confirmed that the existence of plentiful natural resources directs Azerbaijan towards poor economic stability. Ross (2013) highlighted various reasons why abundant resources become a curse such as poor institutions, bad government, corruptive behavior, and poor law and order. Sarmidi et al. (2014) investigated the panel data of 90 economies covering the duration of 1984-2005. He emphasized the significance of good institutions to overcome the misallocation of resources. Zuo and Zhong (2020) confirmed the presence of a resource curse in the resource-rich regions of China due to crowding out effects in research and development along with education. Tiba and Frikha (2018b) selected a sample of 22 African economies and confirmed the existence of a resource abundance phenomenon there. Shahbaz et al. (2018) highlighted that resource abundance accelerates growth while resource dependence hampers it. Tiba (2019) also supports the resource curse theory because of the nonlinearity among oil rents and growth.

2.1 Theoretical framework

In existing literature, many theories have relevance to the theory of resource abundance such as the Dutch disease theory (Corden, 1984), the institutional theory (Mehlum et al., 2006; Eregha & Mesagan, 2016), the staples theory of economic growth (Watkins, 1963), the theory of rent-seeking (Tollison, 1982; Auty, 2015) and the theory of endogenous growth (Romer, 1997, Tiba, 2019). The figure below explains the framework of the present study.

Figure No 2: Research Framework



The above flow chart depicts that natural resources may have a positive effect or a negative impact on sustainable economic growth. The resource blessing hypothesis explains that favorable transmission mechanisms transform these natural resources into blessings and lead toward good economic growth. On the other side, the resource curse hypothesis explains that unfavorable transmission mechanisms transform natural resources into a curse and lead to poor sustainable economic growth.

3. Econometric Approach

In available literature, many researchers examined the linear relationship between labor, capital, natural resource exploration, financial openness, international trade, and sustainable growth. The panel Autoregressive Distributive Lag (ARDL) firstly shows the symmetric reaction of sustainable growth to changes in natural resource exploration. During business cycles, various variables depict asymmetrical behavior. Therefore, there is a need to apply nonlinear ARDL to check the asymmetric behavior of variables. It will permit positive and negative fluctuations in natural resource exploration. Therefore, the following two models have been used by current research to determine the linear and nonlinear effect of the policy variable i.e. natural resource exploration, on sustainable growth following Hussain et al. (2021).

$$SG = f(NRE, \Phi) \quad (1)$$
$$SG = f(NRE^{+}, NRE^{-}, \Phi) \quad (2)$$

In model 1 we undertake labor, capital, natural resource exploration, financial openness, and international trade to be significant factors that may stimulate sustainable growth in developed economies.

$$SG_{i,t} = \beta_0 + \beta_1 NRE_{it} + \beta_n \Phi_{it} + u_{it} \_\_\_\_\_\_\_\_\_\_ (3)$$

We may estimate the Resource Abundance Hypothesis by using the equation given below:

$$SG_{i,t} = \beta_0 + \beta_1 L_{it} + \beta_2 K_{it} + \beta_3 NRE_{it} + \beta_4 FOP_{it} + \beta_5 IT_{it} + \varepsilon_{it} \quad \_\_\_\_\_\_\_\_\_\_ (4)$$

Here (*SG*) shows sustainable growth, L represents labor force productivity and K symbolizes capital respectively. Additionally, (*NRE*) is used for natural resource exploration, (*FOP*) indicates financial openness, (IT) represents international trade. $\mathcal{E}$ shows an error term. Here, subscripts 'i' and 't' represent economy and time duration.

Equation (4) depicts the long-run link among all variables. To analyze the ARDL model technique, it is essential to incorporate the short-run dynamic forces into the long-run equation (4); it is depicted in equation (5).

$$\Delta SG_{it} = \phi_0 + \sum_{j=1}^{k} \phi_{1j}\, \Delta SG_{t-j} + \sum_{j=0}^{K} \phi_{2j}\, \Delta L_{t-j} + \sum_{j=0}^{k} \phi_{3j}\, \Delta K_{t-j} + \sum_{j=0}^{k} \phi_{4j}\, \Delta NRE_{t-j} + \sum_{j=0}^{k} \phi_{5j}\, \Delta FOP_{t-j} + \sum_{j=0}^{k} \phi_{6j}\, \Delta IT_{t-j} + \beta_1 SG_{i\,t-1} + \beta_2 L_{i\,t-1} + \beta_3 K_{i\,t-1} + \beta_4 NRE_{i\,t-1} + \beta_5 TOP_{i\,t-1} + \beta_6 IT_{i\,t-1} + \varepsilon_{it} \quad \_\_\_\_\_ (5)$$

In equation 5 'Δ' denotes the first difference operator, βs represent long-run coefficients, ϕs represents short-run coefficients and $\mathcal{E}_{it}$ represents the error term. Equation 5 could be reconstructed to add an error correction term to estimate the convergence speed of adjustment of the model by following specification.

$$\Delta SG_{it} = \beta_0 + \sum_{i=1}^{n} \omega_{1i}\, \Delta SG_{t-i} + \sum_{i=1}^{n} \gamma_{2i}\, \Delta L_{t-i} + \sum_{i=1}^{n} \delta_{3i}\, \Delta K_{t-i} + \sum_{i=1}^{n} \psi_{4i}\, NRE_{t-i} + \sum_{i=1}^{n} \eta_{5i}\, \Delta FOP_{t-i} + \sum_{i=1}^{n} \Lambda_{6i}\, \Delta IT_{t-i} + \beta_1 L_{it} + \beta_2 K_{it} + \beta_3 NRE_{it} + \beta_4 FOP_{it} + \beta_5 IT_{it} + \Theta EC_{i\,t-1} + \varepsilon it \quad \_\_\_\_\_\_ (6)$$

Here, Ɵ is defined as the coefficient of the ECT. Its coefficient has a negative sign, and it is significant confirming long-run association among all variables (see Table 5). Shin et al. (2014)

developed an asymmetric panel ARDL approach. The main feature of this nonlinear panel ARDL approach is to reconstruct a variable in its positive and negative shocks to formulate an appropriate policy regarding its both asymmetric movements.

In the current research, we will analyze the nonlinear panel ARDL to examine the asymmetric influence of NRE on sustainable growth. The present study decomposes the NRE into its positive and negative shock respectively. In this study, ΔNRE^{+} i, t is representing positive partial sums indicating upward fluctuations in natural resource exploration. On the other side ΔNRE^{-} i, t represents negative partial sums capturing downward fluctuations in natural resource exploration. It is assumed that both positive and negative shocks do not have the same influence on sustainable growth. The decomposed form of natural resource exploration following Shin et al. has been given below:

$NRR^{+}_{i,t} = \sum_{j=1}^{t} \Delta NRE^{+}_{i,j} = \sum_{j=1}^{t} \max(\Delta NRE^{+}_{i,j}, 0)$ and

$NRR^{-}_{i,t} = \sum_{j=1}^{t} \Delta NRE^{-}_{i,j} = \sum_{j=1}^{t} \min(\Delta NRE^{-}_{i,j}, 0)$

In current research the nonlinear panel ARDL model has been made by including short-term and long-term dynamics in the linear panel ARDL representation (Eq. (5)):

$$\Delta SG_{it} = \phi_0 + \sum_{j=1}^{k} \phi_{1j}\, \Delta SG_{t-j} + \sum_{j=0}^{K} \phi_{2j}\, \Delta L_{t-j} + \sum_{j=0}^{k} \phi_{3j}\, \Delta K_{t-j} + \sum_{j=0}^{k}(\phi^{+}{}_{4j}\, \Delta NRR^{+}{}_{i,t-j} + \phi^{-}{}_{4j} \Delta NRR^{-}{}_{i,t-j}) + \sum_{j=0}^{k} \phi_{5j}\, \Delta FOP_{t-j} + \sum_{j=0}^{k} \phi_{6j}\, \Delta IT_{t-j} + \beta 1 SG_{i\,t-1} + \beta_2 L_{i\,t-1} + \beta_3 K_{i\,t-1} + \beta^{+}{}_4 NRR^{+}{}_{i\,t-1} + \beta^{-}{}_4 NRR^{-}{}_{i\,t-1} + \beta_5 FOP_{i\,t-1} + \beta_6 IT_{i\,t-1} + \varepsilon_{i\,t} \quad \text{\_\_\_\_\_ (7)}$$

The long-run asymmetric responses of NRE to positive and negative shocks on sustainable growth are estimated by the coefficients $\beta^{+}{}_4$ and $\beta^{-}{}_4$ while the short-term asymmetric reaction is captured by the coefficients $\phi^{+}{}_{4j}$ and $\phi^{-}{}_{4j}$. The asymmetric error correction form of equation (7) is given below:

$$\Delta SG_{it} = \eta_1 + \sum_{j=1}^{k} \phi_{1j}\, \Delta SG_{t-j} + \sum_{j=0}^{K} \phi_{2j}\, \Delta L_{t-j} + \sum_{j=0}^{k} \phi_{3j}\, \Delta K_{t-j} + \sum_{j=0}^{k}(\phi^{+}{}_{4j}\, \Delta NRE^{+}{}_{i,t-j} + \phi^{-}{}_{4j} \Delta NRE^{-}{}_{i,t-j}) + \sum_{j=0}^{k} \phi_{5j}\, \Delta FOP_{t-j} + \sum_{j=0}^{k} \phi_{5j}\, \Delta IT_{t-j} + ect_{i\,t-1} + \varepsilon_{i\,t} \quad \text{\_\_\_\_\_ (8)}$$

Where $ect_{i\,t-1}$ is indicating that how much time is required to return from short-run disequilibrium to long-run equilibrium.

This study is using panel data covering the time duration of 2000-2021. As per the data availability current research used a sample of 57 developing countries. Their details are given in Appendix A. Table 1 shows the detailed definition of variables along with their data sources.

Table No 1: Description of Variables

Variables	Definition	Source
Sustainable growth (SG)	Growth of Environmentally Adjusted (Green) GDP	OECD Stat, Eurostat, World Bank
Labor force participation (LFP)	Log of labor force participation rate, total (% of total population ages 15-64) (modeled ILO estimate)	WDI
Capital (K)	Log of Capital stock at constant 2017 national prices (in mil. 2017 US$)	WDI
Natural Resource Exploration (NRE)	It is measured through the Mining contribution index (MCI) a PCA Index of Mineral and metal export contribution, Mineral production value expressed as a percentage of GDP, Mineral rents as a percentage of GDP	ICMM Data Base
Financial openness (FOP)	Foreign direct investment, net inflows (% of GDP)	WDI
International Trade (IT)	Trade openness (sum of exports and imports as a percentage of GDP)	WDI

Source: Compiled by author

4. Empirical Results

Descriptive statistics of this research study are given in Table (2). The outcomes of the Jarque-Bera test have affirmed that all null hypotheses regarding normality were rejected, thereby enabling this study to confidently advance with the Nonlinear Autoregressive Distributed Lag (NARDL) analysis.

Table No 2: Descriptive Statistics

	SG	LFP	K	NRE	FOP	IT
Mean	-5.41	4.12	13.09	-5.48E-16	3.72	75.35
Median	-3.46	4.13	12.76	-0.63	2.66	67.08
Maximum	0.43	4.48	18.58	13.37	43.91	220.41
Minimum	-43.15	3.59	8.71	-0.95	-37.17	21.85
Std. Dev.	6.06	0.17	1.95	1.53	4.86	34.83
Skewness	-2.69	-0.55	0.21	3.26	2.52	0.94
Jarque-Bera	5816.26	75.31	26.64	16360.90	23358.47	209.04
Probability	0.00	0.00	0.00	0.00	0.00	0.00
Observations	1254	1254	1254	1254	1254	1254

Source: Author's calculations

This finding is in line with previous research (Shahbaz et al. 2018; Batool et al., 2019). Moreover, it is of utmost importance to identify and explain the issue of multicollinearity between the research variables since its existence can lead to misleading coefficients and results. To tackle this concern, the study calculated correlation coefficients and generated a variance inflation matrix.

In table no 3, the results from the Variance Inflation Matrix, as displayed in Table 3, indicate the absence of multicollinearity concerns among the study variables. The variance inflation factor for each variable pair remains consistently below the critical threshold of 10. These results align closely with earlier research by Sardar and Rehman (2022). The Liven Lin and Chu (LL & C) test for unit root has been used to check whether the variables are stationary at level or first order. Table 3 indicates the outcomes of the unit root test.

Table No 3: Variance Inflation Matrix

	SG	LFP	K	MCI	FOP	IT
SG	-	-	-	-	-	-
LFP	1.03	-	-	-	-	-
K	1.01	1.03	-	-	-	-
NRE	1.07	1.01	1.03	-	-	-
FOP	1.02	1.02	1.06	1.05	-	-
IT	1.04	1.01	1.10	1.00	1.09	-

Source: Author's calculations

Table No 4: Unit root Test

		At Level	At First Difference		At Level	At First Difference
Variables		**Intercept & Trend**	**Intercept & Trend**		**Intercept & Trend**	**Intercept & Trend**
SG	LL & C	-2.70* (0.00)	-	IPS	-	-14.27* (0.000
LFP	LL & C	-	-9.49* (0.00)	IPS	-	-13.99* (0.00)
K	LL & C	-5.03* (0.00)	-	IPS	-	-3.39* (0.00)
NRE	LL & C	-3. 26* (0.00)	-	IPS	-	-21.69* (0.00)
FOP	LL & C	-8.63* (0.00)	-	IPS	-9,63* (0.00)	-
IT	LL & C	-4.87* (0.00)	-	IPS	-3.28* (0.00)	-

Source: (LL&C) represents the Liven Lin and Chu tests for unit root, respectively. Note: Probability values are given in parentheses.

These outcomes signify that the application of panel ARDL is suitable due to the mixed order of integration observed among the variables. Furthermore, considering the substantial sample size, employing this technique is particularly relevant. Furthermore, no variable is stationary at the second difference.

In current research, first, we use the linear panel ARDL approach to judge the symmetric impact of sustainable growth on changes in labor force participation, capital, and natural resource exploration in terms of mining contribution, financial openness, and international trade. Furthermore, this study analyzed the asymmetric behavior of natural resource exploration (mining contribution index) towards sustainable growth by decomposing it into partial positive and partial negative shocks.

Empirical results of model-I and model-II are displayed in Table 5. Model I represent the outcomes of the simple ARDL model. Model II represents the outcomes of the nonlinear panel ARDL model. Table 5 has been subdivided into two parts. Part A depicts the long-run dynamic coefficients of simple ARDL model-I and panel nonlinear ARDL model-II respectively. Part B reports short-run dynamic coefficients of error correction terms for model I and model II respectively.

Table No 5: Results of Short Run and Long Run Dynamics in Developing Economies

Variables	Model-I: Linear ARDL	Model-II: Nonlinear ARDL
	Panel A: Long Run Results	
LFP	-1.17*	-1.54*
	(0.00)	(0.00)
K	0.32*	0.08*
	(0.00)	(0.00)
NRE	-1.92*	--
	(0.00)	
FOP	-0.14*	-0.10*
	(0.00)	(0.00)
IT	0.003*	-0.04*
	(0.00)	(0.00)
NRE^+	--	-2.18*
		(0.00)
NRE^-	--	-3.04*
		(0.00)
	Panel B: Short-Run Results	
ECT (-1)	-0.34*	-0.30*
	(0.00)	(0.00)

Note: *, **, ***, is showing significance level; of 1%, 5% and 10% respectively. Given values in the parentheses representing probabilities.

According to model-I estimated outcomes, the influence of labor on sustainable growth is negative and noteworthy. The results from models (I & II) suggest that in developing economies unlimited natural resources of an economy will be used by excessive labor force. The negative sign of the labor coefficient is that in developing economies labor is uneducated and unskilled. Furthermore, due to technological advancement, the role of labor is a point of debate all over the world. Furthermore, an increase in the labor force will put pressure on sustainable growth. As highlighted by Li et al. (2023), labor market distortions limit the crucial impact of labor in the development of various economies. The outcomes indicate that the effect of labor on achieving sustainable growth is more pronounced in model (II) when compared to model (I).

The results from models (I & II) suggest that capital has a substantial and positive impact on sustainable growth in developing economies. This positive impact indicates that rise in capital triggers positive effects on sustainable growth. This indicates that capital stock plays a positive role to accumulate sustainable growth. According to Tiba et al. (2015), capital accumulation is essential to attain economic prosperity. Furthermore, the impact of capital to achieve sustainable growth is more evident in model (I) when compared to model (II).

Additionally, the result outputs of models (I & II) highlight that the effect of natural resource exploration is destructive for developing economies. This result lends credence to the theory of resource curse hypothesis (RCH) proposed by Sachs and Warner (1995). The inverse effect of abundant natural resources on sustainable growth is linked to the presence of corruption and inadequate investment in human capital. These findings are consistent with the conclusions drawn by previous research studies, including those of Costantini and Monni (2008), as well as Apergis and Payne (2014).

The outcomes indicate that both in models (I & II) the estimated values of financial openness (FOP) are adverse and substantial. It indicates that developing countries must bear the cost of financial openness leading to a decline in sustainable growth. These findings are consistent with Destek and Okumus (2019). This finding supports the Pollution Heaven Hypothesis (PHH) which explains that it is assumed that financial openness positively contributes to developing countries in terms of output, income, and employment generation but this is not the fact. Such economies exhibit the adverse impact of FDI in terms of environmental degradation and health risks.

However, international trade has progressive effects on the sustainable growth of the developing economies as shown in models (I). It indicates that international trade will accelerate sustainable growth in developing economies. International trade (trade openness) was emphasized by the World Trade Organization as an additional source for sustainable development Ridzuan et al. (2018). However, international trade has adverse impacts on the sustainable growth of the developing economies as shown in model II. Present results reinforce the claims that trade openness tends to be both distorting and detrimental to future generations as highlighted by Manni and Afzal (2012).

The outcomes of long-run coefficients of panel nonlinear ARDL (model-II) depict the asymmetric effect of partial positive and partial negative sums of natural resource exploration on sustainable growth. Outcomes indicate that a partial positive sum of natural resource exploration has an inverse and influential impact on sustainable economic growth. This shows that positive shocks in natural resources due to an increase in mining contribution led to a destructive effect on sustainable growth. It leads to a negative effect on sustainable growth by enhancing poor productive activities. Tiba et.al. (2019) also supports this finding. The negative link between natural resource endowment and sustainable growth has also been supported by the Resource Curse theory. Many researchers such as Ding and Field (2005), and Shao and Yang (2014), highlighted this problem and support the presence of a “resource curse”. This explains that the plenty of natural resources generates inverse links and penalizes economic growth.

The coefficient of partial negative sum of natural resource exploration depicts a substantial effect on sustainable growth. The negative coefficient of the partial negative sum of natural resource exploration shows an inverse link between a negative shock in mining contribution and sustainable growth. The negative shock in natural resource exploration indicates effective use of less natural resources to secure future generations and in return, it will result in enhancing sustainable growth. Several existing studies have supported this (Asif et al., 2020; Khan et al., 2022). This demonstrated that economies with plenty of natural resources develop at a slower pace as compared to those who have fewer natural resources. The actual issue causing all this is effective management of lesser resources, good governance, and better institutional policies. The coefficients of both partial positive and partial negative shocks of NRE depict negative symbols indicating an inverse relationship among exploratory and explanatory variables. The magnitude of the negative shock is greater as compared to the positive shock confirming the presence of the resource curse theory that explains that economies with excessive natural resources develop at a low speed due to higher macroeconomic volatility, negative linkage between resource endowment and growth, non-productive activities, corruption, and bad institutions.

These results prove that the panel nonlinear ARDL model is more appropriate than simple linear ARDL as it explains in detail the asymmetric effect of partial positive and partial negative sums of natural resource exploration on sustainable growth by showing significant coefficients. It means that natural resource exploration depicts asymmetric response with sustainable growth in the long run. Panel linear and non-linear ARDL were altered into an error correction model (ECM) to find out the short-run changes. It shows faster response of variables to move to achieve long run equilibrium. The minus symbol of the coefficient depicts convergence in the short run. Table 5 demonstrates the long run and short run results of both models. The long run association among all variables becomes evident due to negative and substantial coefficient of error correction term.

5. Conclusion and Policy Implications

The resource puzzle is extensively inspected by large available literature. Most of the studies support the presence of an inverse link between resource exploration and economic stability. The motive of the present research is to analyze the symmetric and asymmetric influence of natural resource exploration on sustainable growth in the existence of financial openness and international trade. Limited literature decomposed the natural resource exploration into partial positive and partial negative shocks.

Current research focuses on the resource puzzle for a sample of 57 selected developing economies covering the time duration 2000–2021. The ECT coefficient proves the presence of a long-run association amongst all the variables given in both models. The results prove that the panel nonlinear ARDL model is more appropriate than simple linear ARDL as it explains in detail the asymmetric effect of partial positive and partial negative sums of natural resource exploration on sustainable growth by showing significant coefficients. It means that NRE depicts an asymmetric link with sustainable growth in the long run. Furthermore, the coefficients of labor, capital, financial openness, and international trade are also significant having appropriate signs.

The outcomes of both models indicate that the partial positive sum of natural resource exploration depicts an inverse and substantial influence on sustainable growth. This shows that positive shocks in natural resource exploration because of plenty of natural resources lead to an inverse impact on sustainable growth because of corruption and poor institutions. The resource curse theory also provides support for the inverse relation between natural resource endowment and growth. The coefficient of the partial negative sum of natural resource exploration indicates an inverse and substantial effect on sustainable growth. This shows that if countries put less pressure on natural resource exploration it means they are securing them for future generations. Furthermore, limited natural resource exploration may result in less environmental degradation. Less resource exploration will result in efficient resource management leading to sustainable growth.

The policy suggestions for the present study are to prevent bad rent-seeking activities and to avoid poor productivity scenarios to achieve sustainable growth. Furthermore, it is essential now to adopt and support such policies that protect the environment. For future researchers there is an opportunity to empirically compare developed and developing countries and make this research more dynamic. There is option to decompose more variables to get more better policy insights.

6. References

Apergis, N., & Payne, J. E. (2014). The oil curse, institutional quality, and growth in MENA countries: Evidence from time-varying cointegration. *Energy Economics*, *46*, 1-9.

Asekunowo, V. O., & Olaiya, S. A. (2012). Crude oil revenue and economic development in Nigeria (1974-2008). *OPEC Energy Review*, *36*(2), 138–169. https://doi.org/10.1111/j.1753-0237.2011.00205.x

Asif, M., Khan, K. B., Anser, M. K., Nassani, A. A., Abro, M. M. Q., & Zaman, K. (2020). Dynamic interaction between financial development and natural resources: Evaluating the 'Resource curse ' hypothesis. *Resources Policy*, *65*, 101566.

Auty, R. M. (2001). The political economy of resource-driven growth. *European Economic Review*, *45*(4–6), 839–846. https://doi.org/10.1016/S0014-2921(01)00126-X

Auty, R. M. (2015). The political basis of the resource curse. In *Handbook on the Economics of Natural Resources* (pp. 140-162). Edward Elgar Publishing.

Batool, R., Sharif, A., Islam, T., Zaman, K., Shoukry, A. M., Sharkawy, M. A., ... & Hishan, S. S. (2019). Green is clean: the role of ICT in resource management. *Environmental Science and Pollution Research*, *26*, 25341-25358.

Cheang, B., & Palmer, T. G. (2023). A Brief History of Modern Development Thinking. In *Institutions and Economic Development: Markets, Ideas, and Bottom-Up Change* (pp. 35-59). Singapore: Springer Nature Singapore.

Corden & Neary. (1982). *Booming Sector and De-industrialization in a Small Open Country*.

Corden, W. M. (1984). Booming Sector and Dutch Disease Economics : Survey and Consolidation Author (s): W . M . Corden Source : Oxford Economic Papers, New Series, Vol . 36, No . 3 (Nov ., 1984), pp . 359-380 Published by : Oxford University Press BOOMING ECONOMICS : SE.

Oxford Economic Papers, New Series, *36*(3), 359–380.
Costantini, V., & Monni, S. (2008). Environment, human development, and economic growth. *Ecological economics*, *64*(4), 867-880.
Destek, M. A., & Okumus, I. (2019). Does pollution haven hypothesis hold in newly industrialized countries? Evidence from ecological footprint. *Environmental Science and Pollution Research*, *26*, 23689-23695.
Ding, N., & Field, B. C. (2005). Natural resource abundance and economic growths. *Land Economics*, *81*(4), 496-502.
Elhannani, F. E., Boussalem, Bakr, A., & Benbouziane, M. (2016). Financial development and the oil curse: Evidence from Algeria. *Topic in Middle Eastern and African Economics*, *18*(1), 112–125.
Eregha, P. B., & Mesagan, E. P. (2016). Oil resource abundance, institutions, and growth: Evidence from oil-producing African countries. *Journal of Policy Modeling*, *38*(3), 603–619. https://doi.org/10.1016/j.jpolmod.2016.03.013
Erum, N., & Hussain, S. (2019). Corruption, natural resources and economic growth: Evidence from OIC countries. *Resources Policy*, *63*, 101429.
Gylfason, T., & Zoega, G. (2006). Natural resources and economic growth: The role of investment. *World Economy*, *29*(8), 1091–1115. https://doi.org/10.1111/j.1467-9701.2006.00807.x
Hussain, H. I., Haseeb, M., Kamarudin, F., Dacko-Pikiewicz, Z., & Szczepańska-Woszczyna, K. (2021). The role of globalization, economic growth, and natural resources on the ecological footprint in Thailand: Evidence from nonlinear causal estimations. *Processes*, *9*(7), 1103.
Hassan, S. T., Xia, E., Huang, J., Khan, N. H., & Iqbal, K. (2019). Natural resources, globalization, and economic growth: evidence from Pakistan. *Environmental Science and Pollution Research*, *26*, 15527-15534.
James, A., & Aadland, D. (2011). The curse of natural resources: An empirical investigation of U.S. counties. *Resource and Energy Economics*, *33*(2), 440–453. https://doi.org/10.1016/j.reseneeco.2010.05.006
Khan, A. A., Luo, J., Safi, A., Khan, S. U., & Ali, M. A. S. (2022). What determines volatility in natural resources? Evaluating the role of political risk index. *Resources Policy*, *75*, 102540.
Lal, D., Myint, H., & Myint, H. (1998). *The political economy of poverty, equity and growth: A comparative study*. Oxford University Press.
Leng, C., Wei, S. Y., Al-Abyadh, M. H. A., Halteh, K., Bauetdinov, M., Le, L. T., & Alzoubi, H. M. (2024). An empirical assessment of the effect of natural resources and financial technologies on sustainable development in resource abundant developing countries: Evidence using MMQR estimation. *Resources Policy*, *89*, 104555.
Li, Y., Zhang, J., & Lyu, Y. (2023). Toward inclusive green growth for sustainable development: A new perspective of labor market distortion. *Business Strategy and the Environment*, *32*(6), 3927-3950.

Liu, K., Mahmoud, H. A., Liu, L., Halteh, K., Arnone, G., Shukurullaevich, N. K., & Alzoubi, H. M. (2024). Exploring the Nexus between Fintech, natural resources, urbanization, and environment sustainability in China: A QARDL study. *Resources Policy*, *89*, 104557.

Manni, U. H., & Afzal, M. N. I. (2012). Effect of trade liberalization on economic growth of developing countries: A case of Bangladesh economy. *Journal of Business Economics and Finance*, *1*(2), 37- 44.

Mehlum, H., Moene, K., & Torvik, R. (2006). *Institutions And The Resource Curse **. *116*(2001), 1–20.

Mehrara, M. (2009). Reconsidering the resource curse in oil-exporting countries. *Energy Policy*, *37*(3), 1165–1169. https://doi.org/10.1016/j.enpol.2008.10.040

Muhammad, B., Khan, M. K., Khan, M. I., & Khan, S. (2021). Impact of foreign direct investment, natural resources, renewable energy consumption, and economic growth on environmental degradation: evidence from BRICS, developing, developed and global countries. *Environmental Science and Pollution Research*, *28*, 21789-21798.

Neumayer, E. (2006). *Article (refereed) Does the " resource curse " hold for growth in genuine income as well ? Does the ' Resource Curse ' hold for Growth*.

Nurkse, R. (1953). The problem of currency convertibility today. *Proceedings of the Academy of Political Science*, *25*(3), 61-78.

Papyrakis, E., & Gerlagh, R. (2011). Resource-Abundance and Economic Growth in the U.S. *SSRN Electronic Journal*, *62,* 59-101. https://doi.org/10.2139/ssrn.545662

Ranis, G. (1991). Towards a model of development. *Liberalization in the process of economic development*, 59-101.

Ridzuan, A. R., Khalid, M. W., Zarin, N. I., Razak, M. I. M., Ridzuan, A. R., Ismail, I., & Norizan, N. (2018). The impact of foreign direct investment, domestic investment, trade openness and population on economic growth: evidence from ASEAN-5 countries. *International Journal of Academic Research in Business and Social Sciences*, *8*(1), 128-143.

Rostow, W. W. (1959). The stages of economic growth. *The Economic History Review*, *12*(1), 1-16.

Romer, P. (1997). The origins of endogenous growth. *A Macroeconomics Reader*, *8*(1), 3–22. https://doi.org/10.4324/9780203443965.ch26

Ross, M. L. (2013). The Politics of the Resource Curse: A Review. In *SSRN Electronic Journal*. *6*(2), 13–29. https://doi.org/10.2139/ssrn.2342668

Sachs, J., & Warner, A. (1995). Natural Resource Abundance and Economic Growth. *National Bureau of Economic Research*, *3*, 54-65.

Sachs, J. D., Warner, A., Åslund, A., & Fischer, S. (1995). Economic reform and the process of global integration. *Brookings papers on economic activity*, *1995*(1), 1-118.

Sachs, J. D., & Warner, A. M. (1999). The big push is natural resource booms and growth. *Journal of Development Economics*, *59*(1), 43–76. https://doi.org/10.1016/S0304-3878(99)00005-X

Sachs, J. D., & Warner, A. M. (2001). The curse of natural resources. *European Economic Review*, *45*(4-6), 827-838.

Sardar, M. S., & Rehman, H. U. (2022). Transportation moderation in agricultural sector sustainability— A robust global perspective. *Environmental Science and Pollution Research*, *29*(40), 60385- 60400.
Sarmidi, T., Hook Law, S., & Jafari, Y. (2014). Resource curse: new evidence on the role of institutions. *International Economic Journal*, *28*(1), 191-206.
Savoia, A., & Sen, K. (2021). The political economy of the resource curse: A development perspective. *Annual Review of Resource Economics*, *13*, 203-223.
Shahbaz, M., Lahiani, A., Abosedra, S., & Hammoudeh, S. (2018). The role of globalization in energy consumption: A quantile cointegrating regression approach. *Energy Economics*, *71*(84682), 161–170. https://doi.org/10.1016/j.eneco.2018.02.009
Shao, S., & Yang, L. (2014). Natural resource dependence, human capital accumulation, and economic growth: A combined explanation for the resource curse and the resource blessing. *Energy Policy*, *74*, 632-642.
Shaw, D. L. (2013). Good Governance in the Post-Soviet South : Testing Theories of the Resource Curse in Azerbaijan. *Journal of Politics & International Studies*, *9*, 520–561
Shin, Y., Yu, B., & Greenwood-Nimmo, M. (2014). Modelling asymmetric cointegration and dynamic multipliers in a nonlinear ARDL framework. *Festschrift in honor of Peter Schmidt: Econometric methods and applications*, 281-314.
Sharma, C., & Pal, D. (2021). Revisiting resource curse puzzle: new evidence from heterogeneous panel analysis. *Applied Economics*, *53*(8), 897-912.
Tiba, S., & Frikha, M. (2018). Income, trade openness and energy interactions: Evidence from simultaneous equation modeling. *Energy*, *147*, 799-811.
Tiba, S., & Frikha, M. (2019). *The controversy of the resource curse and the environment in the SDGs background : The African context*. *62*(May), 437–452.
Tollison, R. D. (1982). Rent-seeking: A survey. *Kyklos*, *35*(4), 575-602.
Watkins, M. H. (1963). A staple theory of economic growth. *Canadian Journal of Economics and Political Science/Revue canadienne de economiques et science politique*, *29*(2), 141-158.
Zuo, N., & Zhong, H. (2020). Can resource policy reverse the resource curse? Evidence from China. *Resources Policy*, *68*, 101733.

Appendix A

The list of countries used in the research (taken from the United Nation's Report of World Economic Situation and Prospect Report 2022) is given below:

Angola	Namibia
Argentina	Nepal
Bangladesh	Nicaragua
Barbados	Pakistan
Belize	Paraguay
Bolivia	Peru

Botswana	Philippines
Brazil	Saudi Arabia
Burkina Faso	Slovenia
Cambodia	South Africa
Chile	Sri Lanka
China	Tanzania
Colombia	Thailand
Congo, Rep.	Togo
Costa Rica	Tunisia
Cote d'Ivoire	Turkey
Dominican Republic	United Arab Emirates
Egypt, Arab Rep.	Uruguay
Ethiopia	Zambia
Fiji	
Ghana	
Guatemala	
Honduras	
India	
Indonesia	
Iran, Islamic Rep.	
Israel	
Jamaica	
Jordan	
Korea, Rep.	
Lesotho	
Madagascar	
Malaysia	
Mali	
Mexico	
Mongolia	
Morocco	
Mozambique	