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The Dynamic Role of Socioeconomic Transmission Mechanism of Natural Resources to Achieve Sustainable Growth in Developing Economies

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

[1] PhD Scholar, Department of Economics and Statistics, University of Management and Technology, Lahore, Punjab, Pakistan.
Assistant Professor, Department of Management Sciences, Lahore Garrison University, Lahore, Punjab, Pakistan.
Email: f2019330007@umt.edu.pk

[2] Assistant Professor, Department of Economics and Statistics, University of Management and Technology, Lahore, Punjab, Pakistan. Email: farhat.rasul@umt.edu.pk

[3] Associate Professor, Department of Economics, Division of Management and Administrative Science, University of Education, Lahore, Punjab, Pakistan. Email: nabeela.asghar@ue.edu.pk

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ABSTRACT

The influence of natural resources to achieve sustainable growth has been emphasized by the Sustainable Development Goals. Therefore, it becomes essential to study the socioeconomic transmission mechanism of natural resources by focusing the Resource Curse Hypothesis. Current research investigates the presence or absence of the Resource Curse Hypothesis in developing economies. The study applies Panel Quantile Autoregressive Distributed Lag estimation technique for analyzing data of 57 developing countries covering the time duration of 2000-2021. The empirical outcome of the study confirms the existence of the Resource Curse Hypothesis in developing economies. The impact of the macroeconomic stability index is negative and significant indicating poor macroeconomic conditions. The policies to control macroeconomic volatilities, sufficient food provision, good health, and enhanced well-being may help to improve overall outcomes.

Corresponding Author's Email: nabeela.asghar@ue.edu.pk

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1. Introduction

Achieving sustainable development has become an important goal for almost all the countries of the world. For this purpose, it is domineering to utilize existing mineral deposits properly and efficiently to satisfy the present and future needs. This calls for effective measures to mitigate the welfare loss by reinvesting the profits from the extraction of natural resources. The worldwide depletion of capital has raised concerns for planners and policymakers regarding the appropriate planning, management, and utilization of natural resources of the world. The world's natural capital is roughly categorized into 76 percent renewable resources and 24 percent non-renewable resources. The global supply of natural resources has shown a significant reduction of approximately 29 percent in the last three decades. An annual reduction of about 1.10 percent and 1.16 percent has been experienced for nonrenewable and renewable natural resources respectively. However, in the last decade, a 0.34 percent annual growth rate has been observed for renewable resources. About 2.5 percent of the total wealth of the world is depending on nonrenewable resources for instance oil, coal, natural gas, minerals, and metals. In 2018, it added to global gross domestic product almost near to 36 percent. In some countries, these resources have generated a substantial amount of income. However, the distribution of these resources is highly unequal and can be represented by a significant portion of the total wealth in certain nations. Consequently, these resources have served as a crucial determinant of export earnings which have generated revenue for the government.

In fossil-abundant economies, the production of nonrenewable natural resources has exceeded more than one-third of its overall wealth or ninety percent of the nation's total natural resources. These economies are found all over the world, from Saudi Arabia in the Middle East and North Africa (MENA) region to Trinidad and Tobago in Latin America and Caribbean, Azerbaijan in Central Asia, and Equatorial Guinea in Sub-Saharan Africa. Additionally, a sizable portion of nonrenewable natural capital in some nations comes from metals and minerals rather than carbon-emitting fossil fuels. For instance, in 2018, mineral resources made up over 25% of Guinea's natural riches and more than half of Chile's, or 6% and 15% of their respective total wealth, respectively.

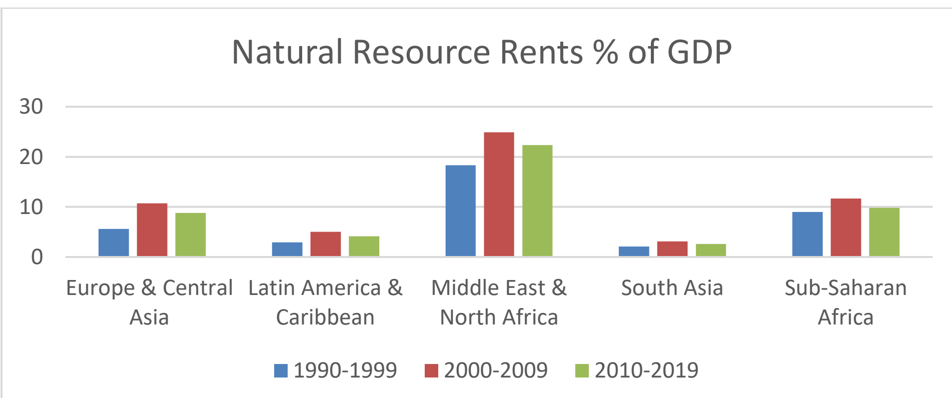

Figure 1: Regional Trends in Natural Resource Rents in Past Three Decades

The exploitation of nonrenewable mineral resources has resulted in an economic surplus which has served as a significant revenue source for the above-mentioned countries, and it has emerged as a substantial component of GDP in most of these countries. The above figure indicates the regional trends in natural resource rents in the last three decades i.e. during 2000-2009. The extraction of natural resources was highest in second decade. This has raised concerns among policymakers regarding the excessive utilization and depletion of natural resources. The 3rd decade has shown a start of shifts toward renewable resources witnessing a slight reduction in natural resource rents which indicates the decrease in the exploitation of natural resources.

The existing resources may serve as one of the fundamental elements of production which leads to revenue generation and provides employment opportunities. Rostow (2013) and Drechsler (2009) have emphasized the effect of mineral deposits in fostering sustainable evolution and have suggested that an economy with an abundance of resources may be more efficient than one with scarce resources. A substantial proportion of government revenues is derived from nonrenewable resources due to the heavy dependency on these resources, and it has become a challenge for the above-mentioned countries to utilize the resources efficiently. Several past studies have shown that on one side resources provide opportunities and on the other side, they become a curse depending upon the nature of the circumstances.

The rent-seeking behavior of economic agents usually promotes non-productive activities that affect adversely other segments of the economy and make it challenging for them to sustain economic stability. The resource curse theory claims that despite availability of natural reserves, many economies struggle to harness their economic benefits. Notably, several studies in existing literature have supported the resource curse hypothesis, (Auty, 2001; Li, Ma, Ruman, Iqbal, & Strielkowski, 2024; Singh, Deep Sharma, Radulescu, Balsalobre-Lorente, & Bansal, 2024).

This duality brings up the need for a comprehensive empirical examination to determine whether the global depletion of natural resources has hindered or facilitated progress toward sustainable development over time. The current century has introduced an innovative domain of tasks that may exacerbate economic difficulties linked with the plenty of natural resources. As, van der Ploeg and Rezai (2020) discuss the potential threat faced by fossil fuel-rich nations regarding the stranding of assets as the fossil fuel era may come to an end and unforeseen changes in the timing and strength of global climate policies may occur.

In recent scenarios, policymakers have agreed that socioeconomic indicators such as health, well-being, education, and better macroeconomic conditions have worked as mediating factors to reduce the tendency of resource curse (See for example,Cockx and Francken (2014). However, some socioeconomic indicators such as poverty, inflation, unemployment, budget deficit, exchange rate volatility, and insufficient food security have harmed sustainable growth by fostering the resource curse phenomenon in developing economies (Makhlouf, Kellard, & Vinogradov, 2017). Therefore, it brings up the need to analyze the association between sustainable growth and natural resource extraction considering the moderating role of socio-economic indicators. For this purpose, the present study develops a link between natural resource exploration and Sustainable Development Goals. Past studies have shown that ensuring access to food, enhancing nutritional standards, and promoting sustainable agricultural practices, good health, and well-being have direct links with natural resource exploration. The link between food security, improved nutrition, sustainable agriculture, and natural resources has also been emphasized in the UNEP Report made by the Food Systems Working Group of the International Resource Panel (IRP) (UNEP, 2016). Besides this, Mignamissi and Malah Kuete (2021), Singh et al., 2024 highlighted the presence of direct association amongst rents, mineral resource rents and happiness if revenues generated from natural resources are properly utilized.

The research enriches the available knowledge in various domains. The significance of present research is that it reexamines the resource curse hypothesis (RCH) in developing economies. It uses the mining contribution index (MCI) as a proxy of natural resource endowment, which has not been used in existing literature before. The major cause of selecting this index is that it is more comprehensive as compared to previously used proxies in the literature like natural resource rents as a percentage of Gross Domestic Product or exports as a percentage of Gross Domestic Product. Furthermore, novelty of this study is that it explains the socioeconomic transmission mechanism more thoroughly by incorporating two sustainable development goals (i.e., SDG2; food security, and SDG3; well-being). This research emphasizes the role of labor and capital by supporting endogenous growth theory. This study uses the most recent technique and provides a comprehensive experiential examination to confirm that developing countries are facing the issue of resource curse hypothesis. In a nutshell this research plays a substantial role in available literature.

The structure of this study is as given, review of available literature is discussed in Section II. Theoretical framework is given in Section III. Details of Section IV deals with data and methodology. Section V presents empirical outcomes and discussion, and the last section concludes.

2. Review of Literature

Several past studies have highlighted the presence or absence of resource abundance in particular economies by adopting different econometric techniques. To determine whether natural wealth positively or negatively impacts economic growth is a complex task. Previous studies suggest that the impact of resources varies, acting as an opportunity or curse depending on specific circumstances. On one hand, resources serve as fundamental production elements, contributing to earnings, generating revenue, and creating job opportunities. Conversely, the crowding-out effect, driven by rent-seeking behavior, can lead to non-productive activities, negatively impacting other sectors and challenging economic stability. This dual perspective underscores the need for a comprehensive empirical examination to understand whether the global depletion of natural resources has impeded or facilitated progress toward sustainable development. Scholars have approached this relationship from different angles, resulting in two perspectives: natural resources as a blessing and natural resources as a curse. The empirical analysis of Resource Blessing Hypothesis and Resource Curse Hypothesis has been made by many researchers using time series and panel data techniques. Now we are going to explain some studies that have explained the above-discussed aspects of resource abundance in detail.

2.1. Natural Resources as a Blessing

In existing literature, many studies support the resource blessing hypothesis. The proposition that assuming other things constant, natural resource endowment is considered to enhance the economic growth of an economy for the long term is well recognized. Author et al. (1997) made a comparison between 22 mineral-rich economies and 57 nonmineral economies. He analyzed how mineral-rich economies performed well as compared to nonmineral economies. He does not endorse the resource curse hypothesis. Lederman and Maloney (2003) suggest that to achieve growth, trade variables pertaining to the plenty of mineral deposits, export concentration, and intra-industry trade are important. Brunnschweiler, Technische, and Zürich (2006) found a progressive empirical association between economic growth and the natural resources. The beneficial effects of resources, particularly subsurface riches, are remarkably strong whether OLS or 2SLS regressions are used. Crucially, their results show that there are no adverse indirect impacts from natural resources via the institutional network. The research of Alexeev and Conrad (2016) posits that a country's ample reserves of oil and minerals exert a direct influence on its persistent economic stability. Furthermore, they refute the idea that natural resources contribute to system deterioration. The contribution of mineral deposits and financial technologies to sustainable development in seven emerging economies with abundant natural resources is evaluated by Leng et al. (2024) over the years 2000–2020. Considering the outcomes, the research endorses that governments and policymakers in these economies apply active policies that encourage the ongoing practice and spread of financial technology as well as the economical withdrawal and usage of natural reserves.

Liu et al. (2024) investigated effects of urbanization, natural resources, and fintech on environmental sustainability during 2000-2020 applying the Quantile-based ARDL technique. They analyzed that China should implement a carbon tax to increase the cost of using non-sustainable energy sources for enterprises. Fintech can be used to promote the green economy in China by facilitating green loans and green finance to ensure green growth.

2.2. Natural Resources as a Curse

Some of the studies have pointed out that the resource deficient economies have experienced three times better growth performance as compared to resource-abundant economies (see for example (Auty, 2001; Sachs & Warner, 1999). Sachs and Warner (1999) analyzed that excessive resources are inversely related to country growth. Kim and Lin (2017) analyzed effect of natural resource dependence on human capital, specifically examining health along with education. Employing a panel time series technique and a large cross-country dataset, the findings indicate that education is positively linked with natural resource reliance, but health is inversely associated with natural resource dependence.

According to Santos (2018) analysis, the gold boom caused a 23.9% drop in school attendance and a 9.3% increase in the likelihood that a youngster would work. Capital accumulation appeared to be steadily declining as the likelihood of a youngster falling three or more grades behind rises by 9%. Resources prove to be a short-term boon but a hindrance to long-term economic progress if human capital is effective. Tiba, Frikha, and Khoudhri (2021) investigated the Resource Curse and environmental problems in 26 African economies from 1990 to 2016. Utilizing panel FMOLS and DOLS methodologies, as well as the Granger causality test based on panel VECM, the research identified a long-run equilibrium link between variables in the Resource Curse Hypothesis (RCH) and Environmental Kuznets Curve (EKC) models. Ali, Mansoob, and Papyrakis (2020) examined the intersection of the "resource curse" and subjective well-being by analyzing the role of resource wealth, particularly oil rents, on happiness across countries. Utilizing a large panel dataset, the research revealed an inverse link between oil rents and advances in happiness. This observed "happiness resource curse" was specific to oil and held for both the degrees and differences in happiness. According to Mohamed (2020), the VECM's empirical results showed that, over time, financial development, life expectancy, school enrollment, and resource rents all had a considerable detrimental impact on economic growth, but development spending had a beneficial effect. It was shown that resource rents had a harmful indirect influence on economic growth by undermining health and education standards. These findings imply that poor human capital indirectly contributes to the resource curse. Yu (2023) highlighted the impact of rents generated from resources on economic progress varies in different economies. The study provided empirical support that in Nepal, Sri Lanka, and Afghanistan the natural resource rents are major hurdles in the way of economic growth but in Pakistan and India the reverse is true. The above literature review concluded that there has been no consensus related to the positive or inverse impact of natural resources to achieve economic growth. In recent scenarios, policymakers have agreed that socioeconomic transmission mechanism of natural resources in alignment of Sustainable Development Goals (SDGs) helps to reduce the tendency of resource curse. Therefore, it brings up the need to analyze the association between sustainable growth and natural resource extraction considering the role of socio-economic indicators.

In a nutshell, this study is essential for precisely assessing the effect of natural resources on sustainable growth of developing countries, given the gravity of the challenges presented by resource depletion, socioeconomic problems, food security limits, and environmental degradation.

3. Theoretical framework

Some researchers, including Kolstad and Wiig (2009) and Al-Kasim, Søreide, and Williams (2013), have also explored the link amongst the abundance of natural resources and rent-seeking actions that cause inefficient production decisions and corrupt institutional behaviors. It results in an inverse relation between resource abundance and economic growth. On the other side, efficient labor, increase in productive investment, macroeconomic stability, better education and employment opportunities, and good socioeconomic conditions serve as a big push to increase the constructive influence of mining contribution for sustainable growth in the developing economies. Figure 2 presents the framework.

The flow chart given below depicts that resource abundance shows an immediate effect on sustainable growth. The impact of food security and wellbeing has been subdivided into two parts (i.e., positive indirect impact or adverse indirect influence of natural resources on sustainable growth). It shows that good socio-economic transmission mechanisms enhance well-being, promote health, and accelerate education. Favorable transmission mechanisms of natural resources transform these resources into blessings and lead toward positive sustainable growth. On the other side, the unfavorable socioeconomic transmission mechanism of natural resources transforms the natural resources into a curse and leads to poor sustainable growth.

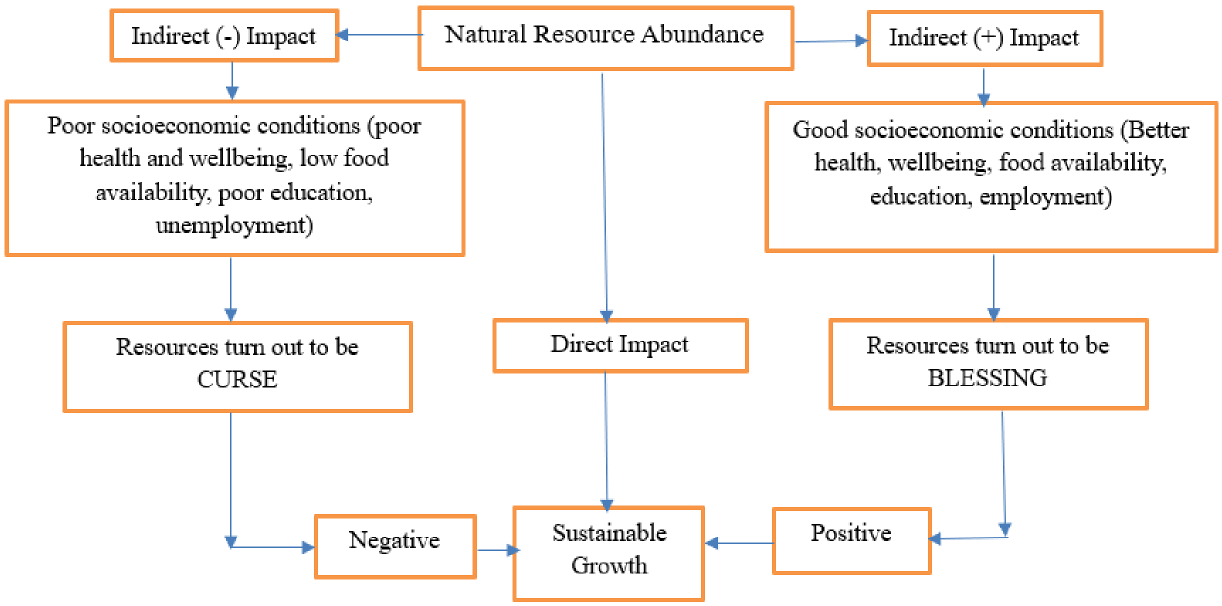

Figure 2: Framework: Socioeconomic Impact of Natural Resources on Sustainable

4. Methodology

For analysis purposes, panel data from 57 developing countries has been obtained for the period 2000 to 2021. This study employs a longitudinal panel dataset spanning 22 years, providing an ample foundation for conducting econometric estimations. The variables and data sources utilized in current research are taken from the sources of data including the World Bank database, OECD Stat, Pen World Table, Sustainable Development Report (SDR) 2022, International Council on Mining and Metal (ICMM) database as given in Table 1.

Table 1

Description of Variables Used in the Study

Variables	Definition	Source
Sustainable growth (SG) (The dependent variable)	Growth of Environmentally Adjusted (Green) GDP	OECD Stat, Eurostat, World Bank
Labor (L)	Log of Total Labor Force	WDI
Capital (K)	Log of Capital stock at constant 2017 national prices (in mil. 2017 US$)	WDI
Mining contribution index (MCI)	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
Food Security Index (FSI)	SDG2: food security, improved nutrition, sustainable agriculture	SDR 2022
Socioeconomic index (SEI)	SDG3: Good Health and Well-Being	SDR 2022
Macroeconomic stability index (MESI)	PCA index of real effective exchange rate, inflation, and budget deficit	WDI

Source: Compiled by author

To address the multifaceted challenges associated with green growth and sustainable development, this study employs the growth of an environmentally adjusted GDP as a proxy of sustainable growth which serves as the dependent variable in our study. By the fundamental neoclassical growth model, capital and labor inputs serve as the fundamental production factors driving economic growth. Therefore, this research incorporates labor inputs and capital investment within the model (Bakari & Tiba, 2019; Fedulova, Voronkova, Zhuravlev, & Gerasimova, 2019). To assess the level of natural resource abundance, the present study utilizes the mining contribution index, which is derived through the PCA index of mineral and metal export contributions, mineral production value represented as a percentage of GDP, and mineral rents as a percentage of GDP. This index is deemed more appropriate than using natural resource rent as a percentage of GDP or the percentage share of primary exports. Besides this, the present study develops a macroeconomic stability index (MESI) through Principal Component Analysis (PCA) by incorporating real effective exchange rate, inflation, and budget deficit. Furthermore, present research practices SDG2 as a measure for food security index and SDG3 (Good health and well-being) to represent the socioeconomic index within the model as explanatory variables along with above discussed variables to measure the presence or nonappearance of resource curse hypothesis in developing economies.

This study uses an advanced form of the ARDL model, known as the Quantile Auto Regressive Distributive Lag Approach (QARDL). It was introduced by Cho, Kim, and Shin (2015). It helps to analyze the asymmetries between explanatory and explained variables. The motive for utilizing the QARDL model is to judge the long-term link at different quantiles of the experimental variable, known as sustainable growth, keeping in view the probable association with the explanatory variables. Xiao (2009) analyzed the advantage of QARDL model on the ARDL model by emphasizing its capability to examine asymmetries. Another important quality of the QARDL approach is its ability to investigate long-run and short-run association between experimental and explanatory variables by focusing on changing market scenarios. Furthermore, it handles cointegration coefficients across quantiles which vary at different times. Besides this, it provides a clear picture of data analysis by overcoming the issue of outliers in the data. In a nutshell, the QARDL technique is efficient in analyzing the nonlinear and asymmetric relationships between sustainable growth, labor inputs, capital investments, mining contribution, food security index, socioeconomic index, and macroeconomic stability index. The operational structure of the model is given below:

$$SG = f\,(L, K, MCI, FSI, SEI, MESI) \qquad (1)$$

Equation (1) depicts the functional form of model. It is a simple model to analyze the phenomenon of resource curse hypothesis in developing countries. Here, *SG* shows sustainable growth, *LF* represents the labor force and *K* symbolizes capital respectively. Additionally, *MCI* is used for the mining contribution index. The impact of *SDG2* has been depicted by (*FSI*; the Food Security Index). The impact of *SDG3* has been represented by (the *SEI*; Socioeconomic Index). *MESI* shows the macroeconomic stability index. Based on the explanations provided above, QARDL approach is considered a fitting and dependable method to evaluate the nonlinear connections between the focal and control variables. The ARDL model equation for this study is depicted in equation (2) given below:

$$SG_{it} = \phi_0 + \sum_{j=1}^{l} \phi_{1j}\, SG_{t-j} + \sum_{j=0}^{m} \phi_{2j}\, L_{t-j} + \sum_{j=0}^{n} \phi_{3j}\, K_{t-j} + \sum_{j=0}^{o} \phi_{4j}\, MCI_{t-j} + \sum_{j=0}^{p} \phi_{5j}\, FSI_{t-j} + \sum_{j=0}^{q} \phi_{6j}\, SEI_{t-j} + \sum_{j=0}^{r} \phi_{7j}\, MESI_{t-j} + \varepsilon_{it} \qquad (2)$$

The error term in equation 2 stated ε_{it} is defined as SG_{it} −E [$SG_{it}/\boldsymbol{\sigma}_{t-1}$]. The minimum field $\boldsymbol{\sigma}$ of variables [SG_t, LF_t, K_t, MCI_t, FSI_t, SEI_t, and $MESI_t$] and symbols l, m, n, o, p, q, r means the lag order of Schwarz information criteria (SIC). The model depicted in Equation (2) was expanded by Cho et al. (2015) to incorporate quantile analysis, and they proposed the following QARDL form:

$$SG_t = \Theta_0 + \rho SG_{i\,t-1} + \varphi_1 L_{i\,t-1} + \varphi_2 K_{i\,t-1} + \varphi_3 MCI_{i\,t-1} + \varphi_4 FSI_{i\,t-1} + \varphi_5 SEI_{i\,t-1} + \varphi_6 MESI_{i\,t-1} + \sum_{j=1}^{p} \beta_{1j}\, \Delta SG_{t-j} + \sum_{j=0}^{q1} \beta_{2j}\, \Delta L_{t-j} + \sum_{j=0}^{q2} \beta_{3j}\, \Delta K_{t-j} + \sum_{j=0}^{q3} \beta_{4j}\, \Delta MCI_{t-j} + \sum_{j=0}^{q4} \beta_{5j}\, \Delta FSI_{t-j} + \sum_{j=0}^{q5} \beta_{6j}\, \Delta SEI_{t-j} + \sum_{j=0}^{q6} \beta_{7j}\, \Delta MESI_{t-j} + \varepsilon_{it}(\tau) \quad (3)$$

Where $\varepsilon_{it}(\tau) = SG_t - Q_{SGt}(\tau / \delta_{t-1})$ (Kim and White, 2003) and $0 > \tau < 1$ is indicating quantile. The QARDL-ECM model in the current study is given in Equation (4), Cho et al. (2015) lead the model to encompass quantile analysis and proposed following Quantile Autoregressive Distributed Lag (QARDL) model form:

$$SGt = \Theta_0(\tau) + \rho(\tau) SG_{i\,t-1} + \phi_1(\tau) L_{i\,t-1} + \phi_2(\tau) K_{i\,t-1} + \phi_3(\tau) MCI_{i\,t-1} + \phi_4(\tau) FSI_{i\,t-1} + \phi_5(\tau) SEI_{i\,t-1} + \phi_6(\tau) MESI_{i\,t-1} + \sum_{j=1}^{p} \beta_{1j}(\tau) \Delta SG_{t-j} + \sum_{j=0}^{q1} \beta_{2j}(\tau) \Delta L_{t-j} + \sum_{j=0}^{q2} \beta_{3j}(\tau) \Delta K_{t-j} + \sum_{j=0}^{q3} \beta_{4j}(\tau) \Delta MCI_{t-j} + \sum_{j=0}^{q4} \beta_{5j}(\tau) \Delta FSI_{t-j} + \sum_{j=0}^{q5} \beta_{6j}(\tau) \Delta SEI_{t-j} + \sum_{j=0}^{q6} \beta_{7j}(\tau) \Delta MESI_{t-j} + \varepsilon_{it}(\tau) \quad (4)$$

It's important to highlight that the Error Correction Model (ECM) parameter, denoted as ρ, is expected to be significantly negative. This is to investigate both the short run and long run asymmetrical effects of variables.

5. Discussions of Empirical Results

Table 2 shows the descriptive statistics for this research study. The results of the Jarque-Bera test have affirmed that all null hypotheses regarding normality are rejected, thereby enabling this study to confidently advance with the Quantile Autoregressive Distributed Lag (QARDL) analysis.

Table 2
Descriptive Statistics

	SG	LNL	LNK	MCI	SEI	FSI	MESI
Mean	-5.41	15.83	13.09	-5.48E-16	60.70	57.69	1.17E-16
Median	-3.46	15.85	12.76	-0.63	66.53	57.84	0.04
Maximum	0.43	20.48	18.58	13.37	95.19	83.59	18.63
Minimum	-43.15	11.36	8.71	-0.95	16.67	30.67	-7.97
Std. Dev.	6.06	1.71	1.95	1.53	20.18	9.01	1.07
Skewness	-2.69	0.10	0.21	3.26	-0.46	0.15	4.26
Kurtosis	12.08	3.41	2.42	19.45	1.95	3.41	85.21
Jarque-Bera	5816.25	11.03	26.63	16360.99	102.00	13.61	356900.6
Probability	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Source: Author's calculations

This outcome is in line with earlier research (Shahbaz, Lahiani, Abosedra, & Hammoudeh, 2018). It is extremely important to perceive and handle the issue of multicollinearity between the variables of the study as its existence causes specious outcomes. Due to this, the coefficient of correlation was estimated, and a variance inflation matrix was formulated.

Table 3
Variance Inflation Matrix

	SG	LNLF	LNK	MCI	SEI	MESI	FSI
SG	-	-	-	-	-	-	-
LNLF	1.002	-	-	-	-	-	-
LNK	1.014	2.850	-	-	-	-	-
MCI	1.072	1.016	1.033	-	-	-	-
SEI	1.202	1.000	1.224	1.043	-	-	-
MESI	1.001	1.001	1.000	1.000	1.003	-	-
FSI	1.055	1.097	1.271	1.013	1.339	1.000	-

Source: Author's calculations

The outcomes from the Variance Inflation Matrix are depicted in Table 3. The current study supports the non-existence of multicollinearity concerns amongst the variables. The Variance Inflation Factor (VIF) for each variable pair remains consistently below the critical threshold of 10 which indicates the absence of multicollinearity. These results align closely with earlier research by Sardar and Rehman (2022). Table 4 displays outcomes of the Liven Lin and Chu (LL & C) and IPS tests utilized to assess the stationarity of the variables at the level or first order. The variables involved in the model come up with a mixed order of integration reflected among the variables. These results signify that the application of panel QARDL is suitable because of the mixed order of integration monitored among the variables. Furthermore, considering the substantial sample size, employing this technique is particularly relevant for effectively addressing potential outlier issues.

Table 4
Unit Toot Test

At Level			**At First Difference**	**At Level**		**At First Difference**
Variables		**Intercept & Trend**	**Intercept & Trend**		**Intercept & Trend**	**Intercept & Trend**
SG	LL & C	-3.22 (0.03)	-	IPS	-2.09 (0.02)	-
L	LL & C	-	-8.90 (0.00)	IPS		-13.83 (0.00)
K	LL & C	-5.03 (0.00)	-	IPS	-3.38 (0.00)	-
MCI	LL & C	-3.26 (0.00)	-	IPS	-	-15.36 (0.00)
SEI	LL & C	-1.89 (0.00)	-	IPS	-	-18.60 (0.00)
MESI	LL & C	-4.12 (0.00)	-	IPS	-	-4.95 (0.00)
FSI	LL & C	-2.72 (0.00)	-	IPS	-3.29 (0.00)	-

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

Table 5 displays the long-term and short-term outcomes of PQARDL for developing countries as proposed by Cho et al. (2015). These results allow us for a more detailed analysis of how social and economic factors impact the utilization of natural resources in developing economies.

Table 5
Results of PQARDL Based on PQR for Developing Economies

Developing Countries Model				
Panel A: Long Run Dynamics			**Panel A: Short Run Dynamics**	
Variables	**Coefficients**	**P-Values**	**Coefficients**	**P-Values**
LF	0.30	0.21	-0.45	(0.43)
K	-0.45***	0.06	2.19*	(0.00)
MCI	-1.16*	0.00	-0.59*	(0.01)
FSI	0.013	0.34	0.012	(0.29)
SEI	0.073*	0.00	0.01	(0.64)
MESI	-0.029*	0.01	0.02	(0.11)
C	-6.942*	0.00	-0.02	(0.50)
Panel B: Cointegration Analysis				
ECM (-1)	-0.05*		(0.00)	
Kao Cointegration Test	-1.69**		(0.04)	

Note: Here, probabilities are in parentheses, and *, **, and ***, showing significance levels; of 1%, 5%, and 10% respectively.

Table 6
Long Run and Short Run Quantile Estimates of Developing Economies

Quantile	ECM (-1)	C	LNLF	LNK	MCI	SEI	MESI	FSI	D(LF)	D(K)	D(MCI)	D(SEI)	D(MESI)	D(FSI)
0.1	0.19* (0.00)	-45.61* (0.00)	2.89* (0.00)	-3.26* (0.00)	-1.09* (0.00)	0.41* (0.00)	0.01 (0.42)	0.09** (0.02)	-5.77* (0.00)	-2.16 (0.22)	-1.02* (0.00)	-0.08*** (0.09)	0.06** (0.02)	0.00 (0.99)
0.2	0.08* (0.00)	-28.53* (0.00)	1.80* (0.00)	-2.16* (0.00)	-1.14* (0.00)	0.27* (0.00)	-0.003 (0.82)	0.05* (0.00)	-2.55* (0.00)	-1.42 (0.16)	-1.05* (0.00)	-0.03 (0.16)	0.03* (0.01)	0.02 (0.43)
0.3	0.01 (0.42)	-15.43* (0.00)	1.11* (0.00)	-1.52* (0.00)	-1.32* (0.00)	0.15* (0.00)	-0.02 (0.11)	0.05* (0.00)	-1.25** (0.05)	0.52 (0.5)	-0.86* (0.00)	-0.01 (0.6)	0.02** (0.05)	0.01 (0.62)
0.4	-0.02*** (0.09)	-10.30* (0.00)	0.73* (0.00)	-0.99* (0.00)	-1.20* (0.00)	0.10* (0.00)	-0.02*** (0.09)	0.02 (0.26)	-0.80 (0.13)	1.60* (0.01)	-0.74** (0.02)	0.004 (0.75)	0.02** (0.05)	0.004 (0.79)
0.5	-0.05* (0.00)	-6.94* (0.00)	0.30 (0.21)	-0.45*** (0.06)	-1.16* (0.00)	0.07* (0.00)	-0.03* (0.01)	0.01 (0.34)	-0.45 (0.47)	2.19* (0.00)	-0.59* (0.01)	0.01 (0.65)	0.02 (0.11)	0.01 (0.29)
0.6	-0.09* (0.00)	-5.27* (0.00)	0.19 (0.33)	-0.30 (0.12)	-1.07* (0.00)	0.05* (0.00)	-0.02 (0.22)	0.01 (0.26)	0.23 (0.67)	2.19* (0.00)	-0.53* (0.00)	0.02 (0.29)	0.02 (0.26)	0.01 (0.4)
0.7	-0.14* (0.00)	-4.34* (0.00)	0.07 (0.71)	-0.18 (0.3)	-1.04* (0.00)	0.04* (0.00)	-0.004 (0.85)	0.01 (0.32)	0.25 (0.76)	3.05* (0.00)	-0.45* (0.00)	0.03 (0.18)	0.01 (0.42)	0.01 (0.42)
0.8	-0.19* (0.00)	-3.64* (0.01)	0.05 (0.8)	-0.13 (0.49)	-0.77* (0.00)	0.03* (0.01)	0.004 (0.83)	0.01 (0.48)	0.49 (0.7)	4.06* (0.00)	-0.47* (0.00)	0.05** (0.02)	0.002 (0.91)	-0.01 (0.7)
0.9	-0.25* (0.00)	-3.16* (0.01)	0.16 (0.34)	-0.21 (0.21)	-0.35*** (0.06)	0.04* (0.00)	-0.002 (0.91)	-0.004 (0.82)	4.55* (0.01)	5.50* (0.00)	-0.31* (0.00)	0.07** (0.03)	0.004 (0.28)	-0.04** (0.05)

Note: Here, probabilities are in parentheses, and *, **, and ***, showing significance levels; of 1%, 5%, and 10% respectively.

Fedulova et al. (2019); Treeck (2018) concluded that there exists a direct link between labor and sustainable growth. Due to labor market distortions labor could not play a significant role in developing economies (Li, Zhang, & Lyu, 2023). The quantile results of the model depict that capital has an inverse and substantial influence on sustainable growth in developing countries. The harmful impact of capital on sustainable growth is because of inefficient use of capital. It will result in fluctuations in investment and drive the business cycle. This shows that capital can be an effective element for reducing sustainable growth. Ocolișanu, Dobrotă, and Dobrotă (2022) also analyzed the adverse influence of capital on sustainable growth. According to quantile estimates of the model the impact of the mining contribution index is negative for developing economies. This finding provides support for the resource curse hypothesis (RCH) (Sachs & Warner, 1999). The resource curse assumption posits that economies richly endowed with natural resources have a higher likelihood of experiencing poorer economic growth compared to economies with limited or no natural resource endowments. Some economies and regions rich in resources frequently behave inadequately. The adverse influence of the resources endowment on sustainable growth is related to the presence of the Dutch Disease and the ineffective investment in human capital. These highlights are like those of (Mehrara, 2009).

The other variable of interest is SDG2, food security. It is represented by the Food Security Index (FSI). The quantile results of model show that in developing economies although the coefficient of food security index is positive, it is insignificant. These findings indicate that developing countries are still facing the issue of less food availability and malnourishment (Tackie, Chen, Ahakwa, Amankona, & Atingabili, 2023). The impact of SDG3; Well-being is measured through the socioeconomic index. Its coefficient is noteworthy in quantile model. It implies that better education, health facilities, and enhancement in subjective well-being show a meaningful part in attaining sustainable growth as highlighted by Pacifico (2023). Furthermore, the influence of the macroeconomic stability index is inverse and major for developing countries. It confirms that macroeconomic volatilities have a damaging substantial impact on sustainable growth in developing economies. Macroeconomic volatility, which can be both a source and an outcome of underdevelopment, is a significant challenge for developing nations. The elevated instability in their overall economic performance stems from a mix of substantial external shocks, fluctuating macroeconomic policies, inflexible microeconomic structures, and fragile institutions. This volatility carries a direct burden for risk-averse individuals in terms of their well-being, and it also exerts an indirect cost by impeding income growth and hindering development (Loayza, Rancière, Servén, & Ventura, 2007). Overall, the findings from model A indicate a statistically significant and negative error correction term, pointing to the occurrence of a long-term association. The results from the Kao Cointegration Test further confirm the existence of co-integration for quantile models (A).

Table 6 presents the outcomes of the model (A) long run and short run panel quantile estimations for developing economies. Notably, long run quantile estimates for the labor force demonstrate a consistently significant and positive impact, particularly at the 1% level in the lowest to lower middle quantile range (0.10-0.40). The influence of the labor force is most pronounced at the lowest quantile level (0.10), followed by the subsequent quantile levels (0.20-0.40). Fedulova et al. (2019) showed a direct correlation between labor and sustainable growth, which aligns with these findings.

The coefficient of capital investment remains negative and significant for all lowest to middle quantile levels (i.e., 0.10-0.50). The quantile estimates of capital show a gradual decrease from lowest to middle quantiles (i.e., 0.10-0.50). The adverse effect of capital will result in fluctuations in investment and drive the business cycle. Ocolișanu et al. (2022) also analyzed the adverse influence of capital on sustainable growth. The quantile outcomes of mining contribution index are noteworthy having inverse impact from lowest to highest quantile (i.e., 0.10-0.90). The negative coefficient of mining confirms the presence of the resource curse phenomenon in developing countries (Asif et al., 2020). The quantile estimates of the socioeconomic index remain positive and significant from lowest to higher quantile levels (i.e., 0.10-0.90). It indicates that better education and health facilities and enhancement in subjective well-being play a significant role in achieving sustainable growth, these results are similar with (Pacifico, 2023). The effect of the macroeconomic stability index has appeared to be negative and noteworthy solely at the lower-middle and middle quantiles (i.e., 0.40-0.50). This observation suggests that volatility not only directly burdens risk-averse individuals in terms of their well-being but also indirectly hinders income growth and development, as highlighted by (Loayza et al., 2007). Conversely, the quantile results for food security index remain positive and significant across the first three quantiles (i.e., 0.10-0.30). This implies that improved food security conditions, coupled with effective governance policies, accelerate sustainable growth in developing economies, an assertion in line with (Lay & Mahmoud, 2003).

The results from the short-run quantile outcomes indicate that the error correction term parameter associated with dependence is substantial and inverse across most quantiles. This suggests that the system rapidly rectifies previous-period imbalances, especially in the higher quantile levels. This observation is consistent with research outcomes of (Khan et al., 2023) and(Baek, 2021). The quantile estimates for the labor force demonstrate an inverse and major role in the first three quantile levels, but it turns out to be direct and significant at the highest quantile level (i.e., 0.90). The quantile estimates of capital investment remain positive and significant from the lower middle to the highest quantile levels (i.e., 0.40-0.90). The quantile results of mining contribution index indicate minus sign and are crucial from lowest to highest quantile (i.e., 0.10-0.90). The negative coefficient of mining confirms the presence of resource abundance theory in developing economies. The quantile estimates of the socioeconomic index remain negative and significant in the lowest quantile (i.e. 0.10). But it turns out to be positive and significant in the higher and highest quantile levels (i.e., 0.80-0.90). It indicates that better education and health facilities and enhancement in subjective well-being portray a significant influence in achieving sustainable growth. The quantile estimates for the macroeconomic stability index remain positive and significant from the (0.10-0.40) quantile levels. These outcomes are similar with the insights provided by Pieloch-Babiarz, Misztal, and Kowalska (2021), indicating a statistically substantial association among the variable of sustainable development and the variable of macroeconomic steadiness. Lastly, the quantile estimates for the food security index reveal an inverse and substantial effect only at the highest quantile level (i.e., 0.90). It indicates that in developing economies poor food security conditions harm sustainable growth. It highlights the need for improved food security, coupled with the availability of new extractive natural resources, to empower people to earn more and improve their livelihoods, as highlighted by UNDP.

Table 7
Wald Test

Test Statistic	Value	Df	Prob.
F-statistic	3799.44	(6, 1247)	0.00
Chi-square	22796.7	6	0.00
Normalized Restriction	Value	Std. Err.	
C (1)	0.11	0.01	
C (2)	0.77	0.01	
C (3)	-0.2	0.11	
C (4)	0.43	0.15	
C (5)	-0.18	0.07	
C (6)	-0.31	0.03	
C (7)	0.24	0.11	
C (8)	0.77	0.01	

Source: Author’s Calculations

The Wald test allows for the detection of instability for both the intercept and coefficients. Another benefit of the Wald test is its ability to identify structural changes with both known and unknown breakpoints. The results of the Wald test for developing economies are detailed in Table 7 for reference.

Table 7 indicates that the results support the rejection of the null hypothesis, suggesting that all independent variables collectively impact sustainable growth in long run. Additionally, graphical representations of error correction term, presented below, affirm long-run link between the variables. Besides this, the graphical presentation which depicts the quantile process coefficients for developing economies in models (A) is also included below, indicating the stability of the variables.

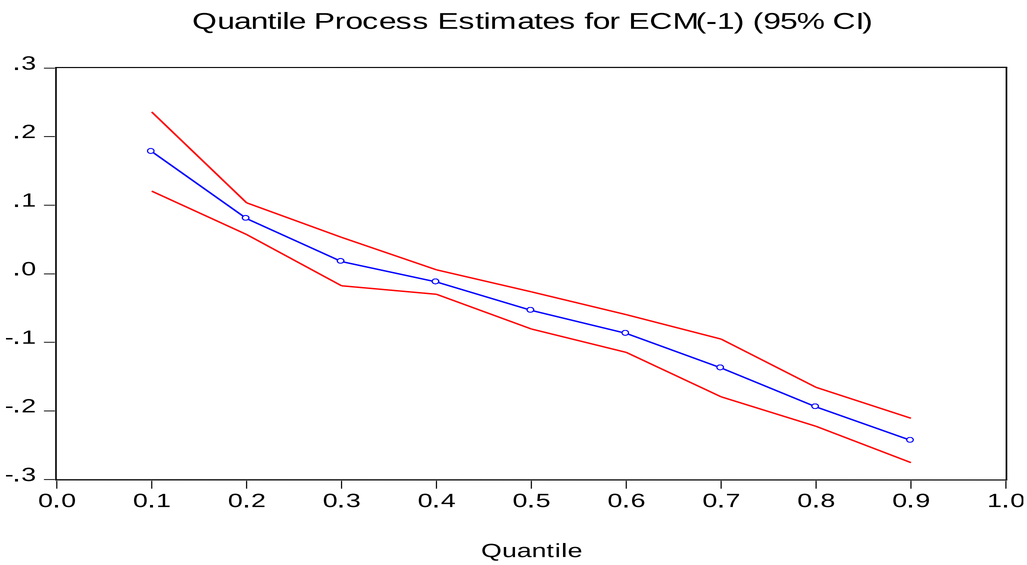

Figure 3: ECM Graph for Developing Economies
Source: Author's Calculations

Furthermore, the graphical presentation of quantile process estimates for models (A) is given below. These graphs show the variations in the variables at different quantile levels.

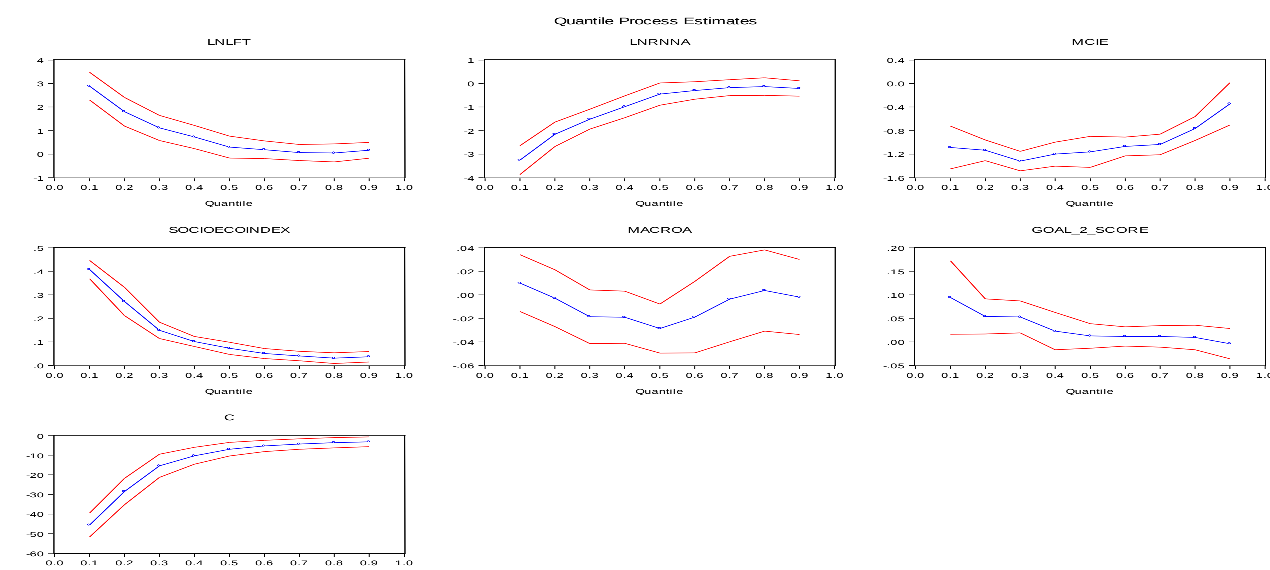

Figure 4: Quantile Process Estimates Graph of Developing Economies
Source: Author's Calculations

6. Conclusion & Policy Implications

Current research illuminates the critical perceptions related to the intricate link between the exploitation of natural resources and sustainable growth in developing economies. Resource endowment, socioeconomic factors, and sustainable growth are topics of debate in the current era. A wide-ranging available literature emphasizes the duplicate role of natural resources on growth. Besides this, the resource puzzle theory constantly exhibits a frequent negative association between resource endowment and economic growth within distinct perspectives. Present research concentrates on the analysis of long-term and short-term influences of the mining contribution index on sustainable growth in developing countries, focusing on the role of the socioeconomic transmission mechanism. The Panel Quantile Auto Regressive Distributed Lag (QARDL) estimation technique is exercised to judge the link between the variables. The quantile estimates of model (A) highlight the substantial inverse influence of mining on sustainable growth in developing economies. The expected growth in population and consumption intensifies burden on natural resources, heading to the deprivation of the environment and the ensuing decrease in sustainable growth in developing countries, as indicated by Eisenmenger et al., (2020). Overall, current research emphasizes crucial policies to achieve macroeconomic stability, confirming adequate food provisions, supporting good health, and improving overall well-being to alleviate bad effects and improve overall conditions. The stated moderation of food security (SDG2) and well-being (SDG3) indicates the crucial importance of strategic planning and efficient use of natural resources to handle the resource curse.

As per the present study analysis, it is imperious for developing economies to apply a multifaceted policy approach that should incorporate the broadening of economic activities to diminish dependence on resource exploitation. Efficient utilization of resource revenues and stringent regulations are mandatory to enforce sustainable mining practices. Moreover, promoting inclusive policies for local communities and investing in agricultural infrastructure can help ensure food security and equitable distribution of benefits. Simultaneously, initiatives for education and skill development, prioritizing health and sanitation programs, and environmental protection measures are important for limiting the harmful effects of resource exploration. Incorporating the Sustainable Development Goals (SDGs) into national policies and promoting stakeholder alliance can further strengthen sustainable growth and reduce the resource curse.

Authors' Contribution

Humera Sherazi: Conceptualization, Methodology, Formal analysis, writing-original draft.
Farhat Rasul: Conceptualization, Supervision, Writing- review and editing
Nabila Asghar: Conceptualization, Supervision, Writing- review and editing

Conflict of Interests/Disclosures

The authors declared no potential conflict of interest w.r.t the article's research, authorship and/or publication.

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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:

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