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Energy security and economic development in large energy user countries

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ABSTRACT

It is widely acknowledged that economic development and energy complement each other, and global economies are consuming enormous amounts of energy to achieve economic growth. One of the prime concerns of policy makers is to ensure energy security in the country for sustainable development. This study examines the short and long run impact of energy security risk on GDP in large energy user countries. A panel Auto Regressive Distributed Lag (ARDL) approach is applied using the data from 1996 to 2020 for 23 countries. The results indicate that increasing energy security risk, in the long run, is negatively associated with all the countries' economic development. However, political globalization and foreign direct investment positively contribute to economic development. Thus, this study recommends that these countries focus more on attracting foreign investment, particularly in renewable energy to avoid uncertainty and long-term sustainability. In addition, there is a pressing need to expand the worldwide political role.

KEYWORDS Energy insecurity; Political globalization; Economic growth; Sustainability; ARDL

INTRODUCTION

Global economies are experiencing significant energy consumption in order to achieve long-term economic growth (Zhang et al., 2018). However, the issue is not just to fulfil expanding demand but also to reduce dependency on dwindling fossil fuels, which have negative socioeconomic consequences. The volatile price dynamics of fossil fuels and the expanding demand-supply imbalance in power need the development of cost-effective, environmentally friendly, and dependable energy alternatives. As a result of these causes, there is a growing interest in creating renewable resources. Global policymakers have mainly understood the importance of the link between energy and economic advancement. As a result, it is widely acknowledged that economic development and energy complement each other (Nawaz and Alvi 2018).

Energy security is multifaceted and can be defined as the uninterrupted availability of energy sources at sufficient quantities and economical prices that align with a country's economic and social development. Economic and Social progress of a nation can be accelerated by the better provision of energy in any economy. It is the main input involved in almost every economic activity. GDP and consumption/production of energy are interrelated because social and economic development of any nation is determined by energy level. Growth in the level of GDP always demands an increase in the energy level (Cicea, *et al*., 2021). Increased energy consumption leads to increase in economic activities which lead to industrial growth and ultimately increase in GDP. Along with the availability of energy sources, the timely investments in energy supplies stimulate economic growth of a country. This implies that the country's economic growth is positively related to the energy security which is evident by many studies (Le et al., 2019; Asafu, 2000; Aqeel and Butt, 2001). The energy crisis of 1970's brought many regions on the verge of energy insecurity due to energy price hike which slowed down their economic growth. The energy insecurity has been a growing concern in Asian economies in the past decade. Population growth accompanied with rapid urbanization are the main factors pushing the demand for energy in this region (Kong, 2015). The rising oil demand in India and China has been aggravating the energy insecurity conditions in these regions (Le et al., 2019). For most developing countries, energy insecurity is a blazing issue where the depleting fossil fuel reserves and the low capacities of transferring to alternative energy options causes impediments in growth and economic activities (Le & Park,2021). Such situations force these countries to rely on energy imports from other countries, further restricting economic activities and growth within the economy (Ahuja, 2009). On the contrary, energy insecurity and low energy supplies will inevitably force the countries to alter their energy consumption structure (Le and Ngyuyen, 2019; Wang et al., 2018). For example, in the wake of energy insecurity caused by the energy shortages and depletion of fossil fuel reserves, Japan spurred its production through the development of green energy technology to achieve economic growth as well as sustainable development (Venhammar, 2017).

Globalization is basically the extension of worldwide linkages among countries. It can be of mainly three types: economic, social and political. Therefore, now a days it is a multidimensional phenomenon which has some pros and cons for developing and developed countries. Globalization creates opportunities for economic development and growth but also generates problems of inequality, poverty etc. Flow of factors of production among nations and trade may generate opportunities for some countries while act as negative externalities for others (Akhter, S., 2013). Kilic (2015) conducted study on globalization and growth taking 74 developing countries and discovered that economic growth is significantly affected by political and economic globalization. The rate of globalization has increased in recent years with political and economic stability further facilitating it. Political globalization is the growth of political systems across the world. An improved fiscal policy within countries and international trade agreements between them further intensifies globalization. Political globalization among nations can increase financial integration and international trade which helps in overall growth of the economy. There is a negative relationship between political instability and GDP growth. The political instability of many developing nations is highlighted as one of the reasons why these nations have not benefited from globalization as much as the emerging countries. Because political instability is related to government inabilities which in turn cannot handles the consequences of globalization like immigration and inequalities. Political globalization can create channels for financial openness among nations which could enhance GDP growth of developing countries.

Foreign Direct Investment is the long-term participation of any country in management, technology transfer or in the form of business in any other country. Financial sector of any economy plays a dominant role in sustainable development of a country through financial development. Financial development shows increase in foreign direct investment. Financial development leads towards increase in the flow of FDI which in turn enhance growth. Financial development enhances the financial and capital markets which in turn increase the consumption of energy (Zhang, 2011). Financial development in any economy attracts FDI and lead towards technological innovations which may help in overall growth of an economy. FDI acts as a consistent source that helps in increasing domestic production capacities, increase investment by providing finance and can uplift technologies (Sirin, 2017). Growth process of any country can be accelerated by FDI by creating employment opportunities, exchange of skills and knowledge. FDI increase real GDP and growth process by many ways: by providing financial resources, by transferring technologies from developed to developing countries, by increasing foreign exchange reserves/balance of payment, by reducing imports and by increasing domestic investment and savings.

Good governance is said to be "the best set of all regulations, laws, practices and processes that influence the functioning of a regulatory framework and the market" (Hancher et al., 2004, p.340). Government effectiveness can help market

forces and legislative framework in making successful policies. Effective government can promote more productive investment, can increase effective division of labor and implement economic and social policies more efficiently than the unstable government. Government effectiveness is helpful in the economies where the market forces are weak and can increase the environment of efficiency in markets by private sector which can accelerate economic growth by accumulating more capital, proper allocation of resources and can guarantee productivity growth by new technological processes (Aljarallah, 2020). An effective government can accelerate the growth of any economy by maintaining competition, income equality, provision of public goods and services. Better governance will attract foreign direct investment, which can solve the balance of payment and increase real GDP (**Okafor**, 2012**)**.

The sources of energy offer the drive for social and economic growth, and the security of energy sources plays an essential role in the security of the country (Löschel et al., 2010). Changes in a country's politics and economics, both domestically and internationally, may significantly affect that nation's energy infrastructure. The majority of countries' energy systems have developed toward a low-carbon, clean, efficient, and safe direction as their economies have entered the New Normal. This represents an internationalized energy supply, slower energy consumption growth, accelerated energy structure adjustment, a greater proportion of clean energy, and other new normal situations. This development takes place against the backdrop of the global development of a low-carbon economy. The previous conflicts has resulted in a rise in global geopolitical threats and has negatively impacted the energy security of the majority of the nations in Europe. However, the rapid growth of the shale gas revolution in the United States has also influenced the energy market (Fang et al., 2018).

Given the importance of energy security and economic development, the present study examines the short and long run impact of energy security risk on GDP in large energy user countries. A panel Auto Regressive Distributed Lag (ARDL) approach is applied using the data from 1996 to 2020 for 23 countries. In the long run, the results indicate that increasing energy security risk is negatively associated with all the countries' economic development. However, political globalization and foreign direct investment positively contribute to economic development.

This study is organized as follows; we have started with the introduction following by section 2, about research method, section 3 is about result and discussion and section 4 conclude the study and give recommendations.

RESEARCH METHOD

2.1. Unit root

Before the estimation, the data requires to be checked for the unit roots. To check the stationarity, the Cross sectionally Augmented Dickey Fuller (CADF) unit root test for panel data is applied to all the variables and find out the order of integration for each variable.

2.2. Auto Regressive Distributed Lag Model (ARDL)

After the panel unit root has been determined, the variables are tested whether they have a long-run cointegration. The study employs the panel Auto Regressive Distributed Lag Model (ARDL) model proposed by Pesaran et al., (1999) and Pesaran and Smith (1995). They combined the Autoregressive (AR) and Distributed Lag (DL) models for cointegration. The ARDL model has many advantages. It produces parameter estimates consistent with the long-term coefficients irrespective of whether these variables are integrated of order (0) or (1).

The estimation model for the ARDL is given below:

$$\Delta lGDP_{it} = \delta_0 + \sum_{i=1}^{k} \delta_1 \Delta ES + \sum_{i=0}^{p} \delta_2 \Delta lPG_{it} + \sum_{i=0}^{q} \delta_3 \Delta FDI \sum_{i=0}^{r} \delta_4 \Delta GE_{it} + \emptyset ES_{it} + \emptyset lPG_{it} + \emptyset FDI_{it} + \emptyset GE_{it} + \mu_{it} \quad (1)$$

Where, *GDP* is the gross domestic product, *ES* the energy security *PG* is the political globalization, *FDI* is the foreign direct investment and *GE* is the government effectiveness

In the dynamic model the error correction term (ECT) specifies the speed of adjustment toward equilibrium. It shows how quickly a variable diverge or converge towards equilibrium. The coefficient with a negative and statistically significant sign assures restoration and convergence towards equilibrium.

$$\Delta lGDP_{it} = \delta_0 + \sum_{i=1}^{k} \delta_1 \Delta ES + \sum_{i=0}^{p} \delta_2 \Delta lPG_{it} + \sum_{i=0}^{q} \delta_3 \Delta FDI \sum_{i=0}^{r} \delta_4 \Delta GE_{it} + \lambda_1 ECM_{t-1} + \mu_{it} \quad (2)$$

The symbol lambda denotes the coefficient of ECM, and its negative and significant sign indicates the existence of a stable long-run relationship.

2.3. Data and Variable description

This study uses the data of GDP for the 23 large energy user countries from the year 1996 to 2020. The data of GDP at constant US Dollars (2015) is obtained from the World Development Indicators (WDI), World Bank. Energy is essential for a society's economic growth, and energy security is vital for any nation's socioeconomic sustainability (Matsumoto and Shiraki, 2017; Nawaz and Alvi, 2018). In this study, we used the energy security risk index as a proxy for energy insecurity. The information is given by the U.S. Chamber of Commerce and Global Institute of Energy for the years 1996 to 2020. High energy security risk score shows higher energy's volatility and insecurity. Foreign direct investment is import for economic growth and development. This study takes the FDI as an independent variable and the data is taken from the World Development Indicators, World Bank. Good governance promotes social and economic policies, leads to higher economic growth and bad governance hindrance the economic development. This study takes the government effectiveness as an independent variable and the data is obtained from Worldwide Governance Indicators, World Bank. Political globalization is used in this study, and it is measured by the number of embassies in other countries, international organizations membership, UN Security Council missions' meeting membership, and the number of treaties signed with other countries.

RESULTS AND DISCUSSION

We have stated this section with the descriptive analysis. Table 1 shows the descriptive results of Energy security risk index and GDP per capita of 23 large energy user countries. The average level of ES in these countries is 12.28 from year 1996 to 2000. The highest average among these countries is of South Korea having 23.14 and the smallest average is of Norway having 2.58. The descriptive results of other variables are provided in Appendix Table A1. The average level of political globalization among these countries is 88.376, the highest of France and the lowest of New Zealand. Government effectiveness is of average 1 among these countries. The highest level of government effectiveness is in Denmark and the lowest is in Indonesia, which clears the picture of development in both countries.

The Panel Unit root results of the dependent and independent variables are mentioned in table 2. The results indicate that all the variables are stationary at level with 1% of significance except for GDP and Government Effectiveness which become stationary after taking the first difference.

Table 3 reports the long run estimates of co-integration among Gross domestic product and independent variables, Energy Security Risk Index, Political Globalization, Foreign Direct Investment and Government effectiveness. The Error correction results for all the regions confirm the existence of short run relationship among the variables. The coefficient of ECM is negative as well as significant which indicates convergence towards long run equilibrium. The coefficient of log of Energy security risk index is negative and significant in the long run which means that in the long run 1 percent increase in Energy Security Risk decreases GDP by 0.53 percent. In contrast, the result for short run indicates insignificant. The coefficient of Political Globalization, Foreign Direct Investment and Government effectiveness have positive relationship with GDP such that an increase in these variables increases economic activity by 0.07, 0.83 and 0.09 percent, respectively.

Table 1: Descriptive Statistics

	ES				**GDP per capita**			
	Mean	Min.	Max.	SD	Mean	Min.	Max.	SD
Australia	6.40	4	10	2.02	41757	19527	68157	16927.27
Brazil	15.66	11	23	3.51	7381.60	2839.49	13245.39	3315.06
Canada	5.76	3	7	1.23	38064.69	21024.59	52669.09	11329.48
China	17.04	8	21	4.18	4381.28	709	10434.78	3466
Denmark	5.47	3	12	1.90	49951.67	30743.55	64322.06	12122.48
France	11.49	9	15	1.84	35128.16	22419.69	45519.29	7720.931
Germany	9.46	7	14	2.35	37742.34	23628.33	48023.87	8600.078
India	19.96	16	22	1.64	1099.55	399.95	2100.75	594.12
Indonesia	12.16	6	19	3.76	2293.12	463.95	4135.20	1310.38
Italy	17.22	12	21	2.53	30689.04	20137.59	40944.91	6367.21
Japan	17.48	12	22	3.16	38838.09	32423.76	49145.28	4177.47
Mexico	3.73	2	11	2.74	8407.58	4412.12	10928.92	1768.73
Netherland	18.29	15	22	2.42	43121.16	26214.49	57879.94	10876.41
New Zealand	3.49	2	5	0.86	30128.14	13641.10	44572.89	11036.46
Norway	2.58	0.67	7	2.23	68440.38	34788.36	102913.45	23405.64
Poland	12.04	10	15	1.62	10059.78	4123.14	15742.45	4326.87
South Africa	16.46	13	20	2.29	5723.19	2797.09	8810.93	1749.81
South Korea	23.14	22	24	0.60	21411.68	8281.69	33436.92	7836.18
Spain	13.83	10	19	2.64	25088.04	14730.79	35510.72	6638.75
Thailand	23.58	22	24	0.64	4340.56	1845.83	7817.009	1960.44
Turkey	16.86	13	21	2.72	8022.94	3053.95	12614.78	3281.55
UK	3.89	1	11	3.37	38590.28	24438.53	50653.26	7612.02
US	6.44	1.00	10.00	2.89	47200.81	29967.71	65279.53	10514.84

Table 2: Panel Unit Root Results

Variable	**CADF Z[t-bar]**	
	I (0)	**I (1)**
GDP per capita	-0.744 (0.228)	-4.403 (0.000)
Energy Security Risk	-2.384 (0.009)	-
Political Globalization	-4.127 (0.000)	-
FDI	-2.957 (0.002)	-
Government Effectiveness	-1.097 (0.136)	-9.740 (0.000)

Note: P-values are reported in parenthesis and show significance at 5 percent.

Table 3: Panel ARDL results

Dependent Variable: Economic Activity (GDP)	**Long run Estimates**		**Short run Estimates**	
Independent Variable	Coefficient	t-Statistic (P-value)	Coefficient	t-Statistic (P-value)
LES	-0.536	-5.24 (0.00)		
D(LES)	-	-	-0.011	-0.123 (0.90)
Political Globalization	0.072	6.55 (0.00)		
D (Political Globalization)	-	-	0.021	2.243 (0.02)
LFDI	0.829	13.74 (0.00)		
D(LFDI)	-	-	0.008	0.533 (0.59)
Government Effectiveness	0.094	0.52 (0.60)		
D(Government Effectiveness)	-	-	0.011	0.205 (0.83)
C	-	-	0.196	2.352 (0.01)
Co-Integration Eq.	-0.050727			
P Value	0.0365			
S.E. Of Regression	0.099490			

Note: P-values are reported in parenthesis and show significance at 5 percent.

CONCLUSION

Global economies use a lot of energy to achieve long-term economic growth. However, the challenge is not just meeting rising demand, but also reducing reliance on depleting fossil fuels, which has severe social effects. The unpredictable price dynamics of fossil fuels and the growing power demand-supply mismatch.

It is common information that economic growth and energy consumption go hand in hand. At the same time, it is also completely obvious that economies worldwide are using vast quantities of energy to accomplish economic growth. To guarantee the continued and sustainable growth of the nation, one of the primary concerns of decision-makers is the nation's energy security. This research investigates the short-term and long-term effects of energy security risk on GDP in nations with high energy use. The data for 23 nations are put into a panel Auto Regressor Distributed Lag (ARDL) technique, and the time period from 1996 to 2020 is used. According to the findings, an increase in the risk to energy security has a long-term, negative association with economic growth in every country.

On the other hand, political globalization and direct investment from other countries are both contributing in a favourable way to economic growth. Accordingly, the findings of this research suggest that these nations place a greater emphasis on luring outside investment, particularly in the field of renewable energy, to reduce the likelihood of future uncertainty and ensure its long-term viability. In addition, there is an urgent need to broaden the political role played on a global scale.

The world's top worry now is energy security, which is on the global agenda. Over the past four decades, the world's emphasis has shifted from imported, costly energy supplies to less-priced renewable energy sources that also provide socioeconomic and environmental sustainability. Diversification of energy resources and the best possible use of indigenous resources should be part of any national policy.

The European Union (EU) and other countries around the world are still susceptible to disruptions of the energy system that originate either from the outside or from within. These disruptions can be brought on by a variety of factors, including those that are economic, technical, or geopolitical in nature (Augutis et al., 2017). This is outlined not only in the previously stated strategies but also in the strategic initiatives. In order to improve our energy security, we need to make decisions that will lessen our reliance on certain types of fuel, energy suppliers, and transportation routes. On the other hand, key papers with a high strategic value highlight the significance of energy security in the context of the energy sector of a contemporary society.

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APPENDIX

Table A1: Descriptive Statistics

			Pol. Glob.			Govt. Effect.		
	Mean	Min.	Max.	SD	Mean	Min,	Max.	SD
Australia	87	83	89	1.74	1.70	1.53	2.01	0.114
Brazil	87	83	92	2.84	-0.11	-0.45	0.20	0.15
Canada	91	90	92	0.78	1.83	1.71	1.99	0.09
China	86.22	77.47	91.88	4.21	0.09	-0.35	0.48	0.23
Denmark	92.23	90.73	93.34	0.72	2.01	1.76	2.35	0.18
France	97.39	95.99	98.49	0.74	1.50	1.25	1.78	0.14
Germany	96.48	94.98	97.72	0.86	1.64	1.42	1.88	0.133
India	88.65	81.22	93.50	3.58	-0.036	-0.206	0.28	0.119
Indonesia	81.94	74.88	89.39	4.58	-0.28	-0.705	0.18	0.24
Italy	96.18	91.68	98.65	2.12	0.57	0.19	0.87	0.19
Japan	84.42	79.26	88.73	2.79	1.43	0.91	1.86	0.29
Mexico	77.15	68.34	87.82	6.45	0.19	-0.16	0.36	0.11
Netherland	94.59	92.05	97.01	1.62	1.89	1.69	2.09	0.124
New Zealand	75.25	69.64	77.56	2.193	1.77	1.59	1.96	0.09
Norway	87.94	85.72	90.02	1.30	1.91	1.83	2.08	0.06
Poland	91.013	89.30	93.27	1.06	0.59	0.373	0.75	0.10
South Africa	82.93	57.72	91.48	9.29	0.51	0.19	1.02	0.21
South Korea	85.63	74.57	92.19	4.93	0.97	0.36	1.25	0.27
Spain	94.47	91.31	96.94	2.11	1.27	0.80	1.88	0.37
Thailand	76.79	65.80	81.76	4.72	0.28	0.06	0.45	0.09
Turkey	89.73	84.15	93.50	2.73	0.13	-0.26	0.41	0.18
UK	96.64	95.83	97.65	0.50	1.69	1.39	1.93	0.16
US	92	92	93	0.25	1.48	1.22	1.92	0.18