Economic Policy Uncertainty and the Energy Growth Nexus in India : A Reassessment

[1]Shahida Rasheed
[2]S. M. Shafi
[3]Iqra Yaseen
[4]Syed Farhat Bashir

Abstract

This study analyzes the intricate relationship between economic policy uncertainty (EPU) and India's energy-growth nexus (1997-2022) using ARDL and machine learning (ML) techniques.

ARDL results confirm the positive influence of energy consumption on economic growth in both the short and long run, while EPU exerts a negative impact. Notably, the interaction between EPU and energy consumption fosters economic growth. Toda & Yamamoto causality tests further corroborate EPU's impact on energy consumption and economic growth. ML models (MLR, RFR, GBR), employing F1-score feature significance, identify carbon emissions, EPU, and energy use as key GDP predictors, underscoring India's challenges in achieving SDGs related to environmental sustainability (SDG 13), economic stability (SDG 8), and energy efficiency (SDG 7). These findings emphasize the need for coordinated macroeconomic policies to mitigate uncertainty, particularly in the context of energy transition and regulatory frameworks, to promote sustainable and inclusive development

Keywords: *Economic policy uncertainty (EPU), economic growth (EG), energy consumption (EC), GDP prediction, Machine learning (ML).*

1. Introduction

Energy resources are significant catalysts for fostering economic development. Over the past two decades, numerous studies have evidenced that growth-energy nexus (Belloumi, 2015; Odugbesan & Rjoub, 2020; Pejović et al., 2021; Shahbaz et al., 2020; Usman et al., 2022; Waleed et al., 2018; Zhi-Guo et al., 2018). Several theories and empirical studies have investigated the mechanism and relationship among different spheres of energy-growth nexus (Ahmad et al., 2016; Shahbaz et al., 2020; Zhi-Guo et al., 2018). The incessant debate over the growth-energy nexus has led to the development of four hypotheses: the neutrality hypothesis, where there is no relationship between economic growth and energy demand (Ahmed, 2019; Omri, 2017; Ssebabi et al., 2021); feedback hypothesis, where there is interlinkage between energy-growth nexus (Bildirici & Bakirtas, 2014; Hussain et al., 2019; Phukon & Konwar, 2019), conservation hypothesis, where economic growth leads to energy consumption (Apergis & Foon, 2013; Behera, 2015; Rani & Kumar, 2019) and growth hypothesis, where high level of energy demand increases economic growth (Alshehry & Belloumi, 2015; Odugbesan & Rjoub, 2020; Victor & Asumadu, 2019). Recent empirical studies on economic growth and energy consumption nexus have focused on multivariate and empirical econometric approaches. These studies have used additional variables like CO_2 (Danish et al., 2018),

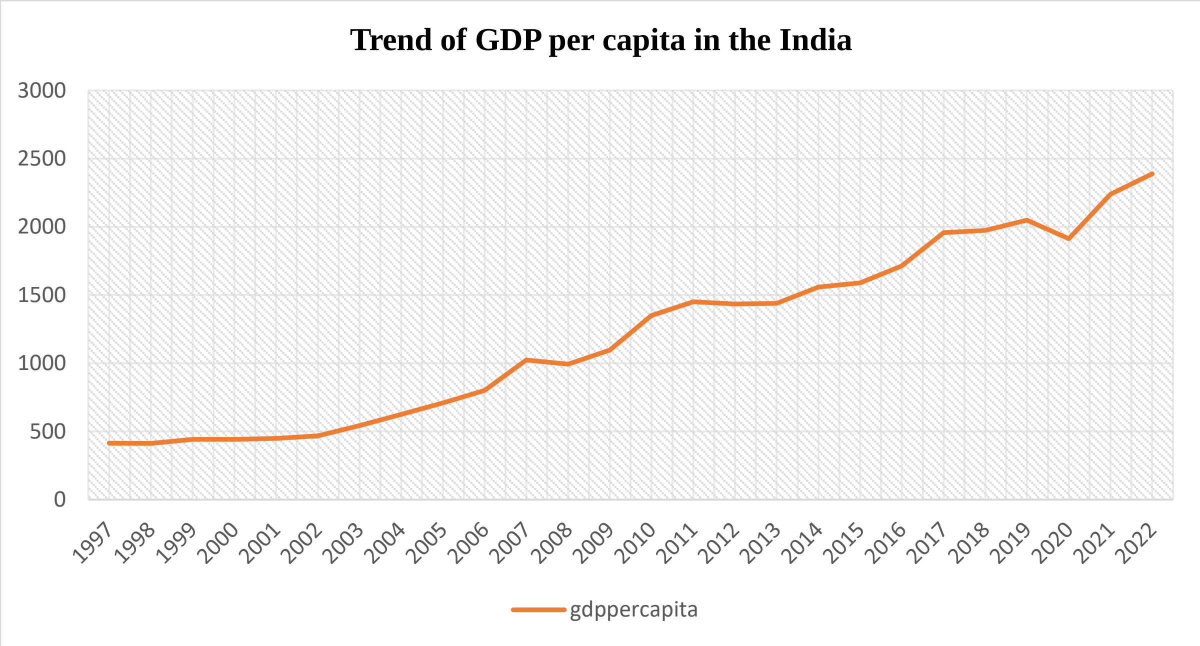
[1] *Department of Commerce, University of Kashmir ; email:shahidarasheed626@gmail.com*
[2] *Department of Commerce, University of Kashmir ; email:shahidarasheed626@gmail.com*
[3] *Department of Commerce, University of Kashmir ; email:shahidarasheed626@gmail.com*
[4] *Department of Commerce, University of Kashmir; email:syedfarhatb@gmail.com*

urbanization (Wang & Cao, 2021) financial development (Khan et al., 2021), international trade (Kongkuah et al., 2021), energy prices (Carfora et al., 2019), human capital (Fang, 2016), FDI (Udi et al., 2020), globalization (Acheampong et al., 2021) to identify the causal relationship between energy-growth nexus.

However, in the last few years, the global economy has come across major events that have highlighted climate change concerns and political and policy uncertainty. Noticeably, every uncertainty, such as political, social trade, or conflict, considerably affects economic activity (Adams et al., 2020; Jiang, 2018; Marion, 1991). The major global uncertainties like the Global financial crises of 2008 (Bordo & Meissner, 2009; Countries, 2009) Covid 19 pandemic (Apergis et al., 2021; Chaudhary et al., 2020) have witnessed considerable fluctuations in the economic environment policies, and structures around the globe, which results in lower economic growth, impacts the economic decision making of entities and eventually affects governments, corporations and individuals (Anser et al., 2021; Doğan & Güler, 2020). In other words, under an economic uncertainty period, people and firms act more conservatively, i.e., postpone their future consumption and investments, leading to an overall fall in economic growth (Bloom, 2009; Caggiano et al., 2017; Wen et al., 2022). Similarly, economic policy uncertainty can reduce both production of energy and consumption of energy-intense products, which subsequently reduces the energy demands (Wang et al., 2020; Wei et al., 2021). This tendency stimulates economic risk, impacting individuals' and businesses' spending and investing activities (Al-thaqeb & Ghanim, 2019). Extensive literature (Chukwudi & Edwin, 2022; Erzurumlu & Gozgor, 2022; Gu et al., 2021; Khanh et al., 2022; Sharma & Paramati, 2021; Su et al., 2021) exists on assessing the effects of (EPU) in both developing and developed countries. However, there is limited research on how economic Policy Uncertainty (EPU) impacts India's economic growth and energy relationship.

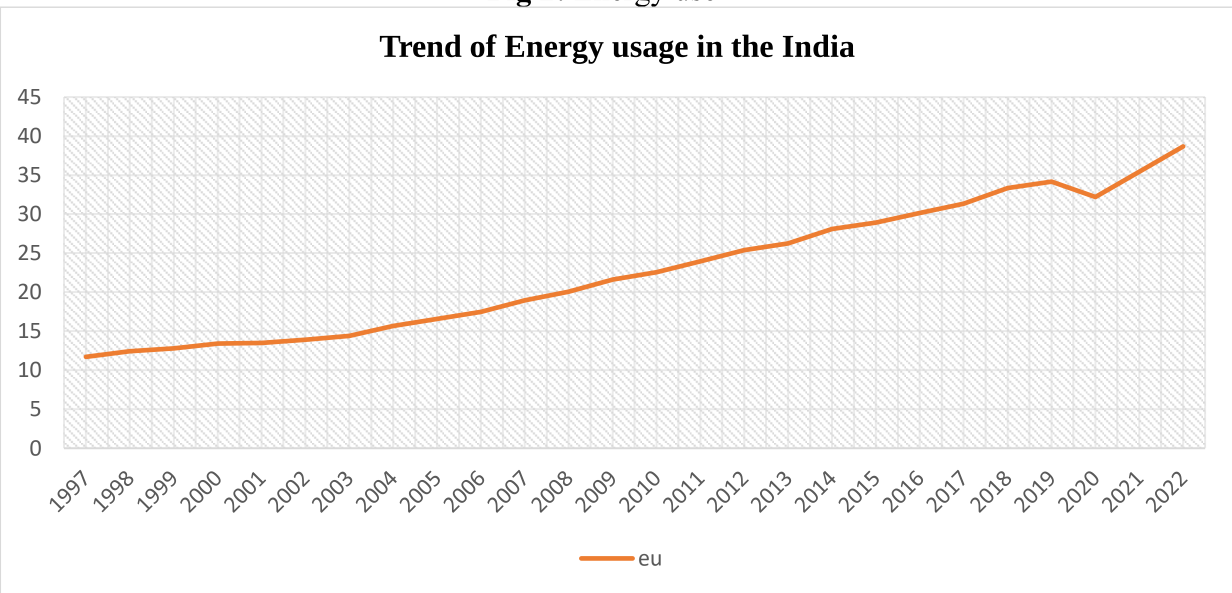
Examining patterns in GDP/capita and primary energy use/capita for a developing nation like India (Fig.1 and 2), real GDP per capita underwent a significant surge from 1997 to 2008, exhibiting a gain of roughly 50% over this timeframe. The real GDP/capita increase is linked to an upsurge in energy consumption. From 1997 to 2008, energy usage rose from approximately 10 to 20 units, doubling primary energy consumption. Furthermore, India had swings in its real GDP per capita, particularly in 2004-2005 because of political turmoil, in 2008-2009 during the Global Financial Crisis, and in 2012 when the economy encountered obstacles in infrastructure investment and development. In addition, the emergence of the COVID-19 epidemic in 2019 significantly impeded India's economic recovery, resulting in unparalleled levels of economic policy uncertainty (EPU). In developing countries like India, primary energy consumption increased during periods of uncertainty. To counter the economic challenges, industries and business often intensify their operations, leading to heightened energy demands for manufacturing and production processes. Moreover, the government implements measures during economic downturns, inadvertently driving up energy consumption via increased construction, transportation, and energy-intensive projects. However, energy consumption for 2020 was low, which marked a notable departure from the trend, indicating a decline in primary energy consumption and a distinct role towards prioritizing environmental considerations.

Fig 1 Gross Domestic Product per capita



Source: *WDI*

Fig 2: Energy use



Source: *WDI*

Given this backdrop, the main motive of this paper is to evaluate the role of economic policy uncertainty on the energy-growth nexus. This paper highlights the literature gaps: Firstly, instead of focusing solely on the energy-growth nexus, this study incorporates the EPU in the energy-growth relationship in India to better comprehend the relationship. India is one of the largest and fastest-developing countries in South Asia, and it is projected to grow significantly, with an increase in growth rate from 5.53%-8.95% between 1990 and 2021. However, since 2004, due to immediate policy uncertainty and the absence of satisfactory economic reforms, the Indian economy has faced structural glitches that inescapably affect macroeconomic and corporate decisions. Further, limited research is done on the impact and consequences of economic uncertainty on the Indian economy. Secondly, the sample period is considered an important economic policy uncertainty period, like the Indian demonetization in 2016 and the

Covid-19 pandemic in 2020, which significantly aids in mirroring the impacts of economic policy uncertainty.

Subsequently, the paper is structured as follows: Section 2 extensively discusses the existing related work. Section 3 presents the details of the data used and the econometric methods applied. The empirical results, conclusion and future directions are discussed in sections 4&5.

2. Literature Review

Previous studies have investigated the effect of EPU on economic activities worldwide. This study considers three streams of literature, i.e., the Energy-Growth Nexus, the impact of EPU on macro-economic variables and the impact of EPU in India.

2.1 Theoretical Background

The energy-growth nexus theoretical underpinning is based on four hypotheses. (i) Firstly, the growth hypothesis argues that energy consumption stimulates economic growth directly and indirectly by complementing labour and capital in the production process. (ii) Secondly, the conservation hypothesis suggests that implementing measures such as reducing carbon emissions, improving efficiency, and managing demand to decrease energy consumption and waste does not negatively affect economic growth. (iii) Thirdly, the feedback hypothesis accentuates that energy consumption and economic growth complement each other. Thus, energy conservation policies should be formulated in a manner that is not destructive to economic growth. (iv) Fourth, the neutrality hypothesis concludes that energy usage is a relatively small part of total output. Therefore, it has little or no impact on economic output (Alper & Oguz, 2016; Salisu & Ogbonna, 2019; Ssebabi et al., 2021).

During an uncertain period, economic agents change their behaviour, delaying their irreversible decision-making until there are improvements in economic circumstances. According to real option or adjustment cost effect, those investment decisions withdrawn by managers during the uncertainty are inherited by the charges of reorganizing the labour, financial assets, and infrastructure (Čižmešija et al.,2017). Furthermore, uncertainty impacts the selling price, where sellers must accept a reduced price to make their selling decisions. (Gilchrist et al., 2014).Decision makers, both consumers and managers, become risk averse, focusing on saving rather than investing during the uncertainty period. According to the precautionary view, Ren et al. (2020) establish that an uncertain period puts a stake in external financing, ultimately reducing investment, research and development. Furthermore, that increase in credit spread is an outcome of uncertainty, which produces lower returns and leads to deferment of loan demands. Economic uncertainty also impacts the financial markets by increasing costs, ultimately making it problematic for companies to acquire loans and advances from financial institutions. Furthermore, it increases the volatility in the stock market's returns. To summarize, this type of behaviour will ultimately negatively impact economic growth.

2.2 Energy -Growth Nexus

Various studies have been directed on this nexus (Omri, 2017; Ssebabi et al., 2021) provided the literature review on energy-growth nexus, resulting in mixed results. Further, some studies have shown that energy causes economic growth. (Foon et al., 2016) confirmed the long-term connection in Vietnam. Also, (2019) confirmed the hypothesis of energy-led growth in Pakistan. Further, NARDL estimation discloses asymmetric cointegration among variables. Similarly, (Adebayo, 2021; Bhattacharya et al., 2015) confirm South Korea's and China's growth hypothesis. While other studies argue that economic growth induces energy consumption, for instance, Rahman & Velayutham (2020), by applying the Dumitrescu-Hurlin panel causality test to examine the link between the energy-growth nexus in five South Asian nations from 1990 to 2014, revealed a one-way link from growth -energy usage. Also, Destek

(2016) supports the conservation hypothesis in newly industrialized countries from 1971-2011 through the asymmetric causality approach. Similarly, Vo et al. (2019) confirm a uni-directional link between GDP and non-fossil fuel energy usage in Indonesia.

Studies like Li and Leung (2012) reveal bi-directional causality between coal consumption and GDP in coastal and central regions of China. A one-way relationship between GDP -and coal consumption is confirmed for the western region. Further,(Hussain et al., 2019; Park & Yoo, 2014) also confirms a bi-directional relationship between oil usage, energy usage and GDP in Malaysia from 1965-2011 and 1978-2016. In contrast with the above three literature strands, some studies contend that there is no relationship between energy. Shaari et al. (2013) confirm no causality between economic growth and (oil and coal consumption in Malaysia from 1980-2010. Similarly, Ozcan & Ozturk (2019) confirm the neutrality hypothesis with the help of a bootstrap panel test between energy-growth relationships in 16 emerging economies from 1990-2016.

To the best of our knowledge, the empirical papers (Al-mulali & Che Sab, 2018; Behera, 2015; Bildirici & Bakirtas, 2014; Chandran Govindaraju & Tang, 2013; Ghosh & Kanjilal, 2014; Lin et al., 2018; Ohlan, 2016; Shastri et al., 2020). Based on the multivariate model Lin et al., (2018) investigated the nexus between CO2 emission and economic -growth using Bootstrap ARDL from 1969-2015. The results support the growth hypothesis. Similarly, Ghosh & Kanjilal (2014) reveal a long-run connection between energy use and GDP using ARDL bound test and the Johansen procedure for cointegration over 1971-2008—further, a uni-directional relationship from energy-economic growth indicated by Todae Yamamoto causality estimation. Similarly, Shastri et al. (2020) examine the GDP, fossil, and non-fossil energy relationship from 1971-2017 using NARDL and asymmetric causality tests. The results show an asymmetric impact of energy use for both long /short run. Correspondingly, indicates a unidirectional causality from non-renewable and renewable consumption to economic growth. Further, Ohlan (2016) found evidence of a two-way relationship between non-fossil energy consumption and economic growth in both the long and short term. Additionally, there is only a one-way relationship between renewable energy consumption and economic growth in the short term. Similarly, Bildirici & Bakirtas, (2014) confirms a bi-directional casualty between coal usage and economic growth. Moreover, Behera, (2015) confirms the long-run relationship between GDP and energy use, further confirming the one-way relationship between economic expansion and energy use. Similarly, Chandran Govindaraju & Tang (2013) confirmed a one-way relationship where economic growth influences coal use. Furthermore, (Al-mulali & Che Sab, 2018; Carfora et al., 2019; Lei et al., 2014) advocate no relationship between energy use, coal and economic growth in India.

2.3 Energy consumption, economic growth, and EPU

Economic policy uncertainty refers to ambiguity in government- policies (Fiscal/monetary policies) (Abbasi & Adedoyin, 2021; Baker et al., 2016). EPU induces political uncertainty and weak economic and financial structures, negatively impacting Pakistan's GDP in both the short and long run (Wen et al., 2022). Similarly, Bhowmik et al. (2022) examine the impact of fiscal, monetary, and trade policy uncertainties on the US environmental Phillips curve. The results disclose that uncertainty in fiscal policies reduces energy usage and growth, decreasing CO2. Uncertainty in monetary policy decreases investments in clean energy, research and development, and technology, resulting in elevated carbon emissions. However, uncertainty in trade policy has no impact on carbon emissions. Another study by Chukwudi & Edwin, (2022) inspects the moderating effect of EPU on the energy environment, implying that EPU encourages fossil energy consumption, resulting in corrosion of environmental quality. Therefore, EPU has an ameliorating impact on energy usage, thus accelerating carbon emissions. Similarly, Zakari et al., (2021) discovered that economic policy uncertainty impacted the environments in OECD countries from 1985-2017, and PMG -ARDL results reveal that EPU positively impacts carbon emission. Also, Adedoyin,(2021), confirms the positive impact of EPU on environmental degradation in the top ten tourism-based countries. This confirms that EPU impacts the environment through its economic activities, such as investment, stock market, and trade. Further, Qamruzzaman, (2022) found that EPU reduces the institutional quality in both countries (India &Pakistan) over a period of (2003:Q1 – 2019Q4).

Moreover, the literature has highlighted the impact of EPU on the firm level. For instance; (Phan et al., 2019) investigates the impact of EPU on cash holdings of US public companies from 1986-2015. During the uncertainty period, high-growth firms take precautionary measures by limiting their investments, which certainly leads to excess cash reserves. Similarly, Demir & Ersan, (2017), also found a positive impact of EPU on cash holdings in BRIC nations. Bonaime et al. (2018) investigated the relationship between EPU and mergers/acquisitions from 1985 to 2014. Policy uncertainty strongly impacts mergers and acquisitions at the country and firm levels. In addition, Jin et al., (2019) confirm the positive impact of EPU on stock price crash risk. Subsequently, firms have information asymmetry, and firms have disagreements with investors. Managers conceal bad news during economic uncertainty from investors, and thus, these firms are more prone to stock crashes. Gupta (2022) explores the impact of EPU on investment cash flow sensitivity in Indian firms; the study discloses that EPU has a positive effect on investment cash flow sensitivity and a negative impact on firm investment. Further, the CEO's educational background contributes to mitigating the negative impact of EPU on investment cash flow sensitivity. Since EPU makes external financing costly, it left internal cash flow as the only option.

3. Data & Methodology

3.1 Methods

The conventional theoretical framework of the energy-growth nexus encompasses variables such as FDI, trade openness, carbon emission and urbanization (Menon et al., 2023; Rehman & Rehman, 2022; Zameer et al., 2020) in India. However, this empirical study fails to consider the EPU cannel when analyzing the energy-growth relationship. This study employed the ARDL method to explore the influence of EPU on energy-growth nexus. The Autoregressive Distributed Lag (ARDL) methodology provides numerous methodological benefits in econometric analysis. Significantly, its adaptability is a crucial advantage as it can proficiently manage models consisting of both on-order 1(0) or (1) variables (Qamruzzaman, 2022). One of the crucial advantages of this approach is that it removes the requirement for pre-testing for unit roots or cointegration. This simplifies the modelling process and avoids potential problems in testing numerous hypotheses (Adedoyin & Zakari, 2020). Furthermore, ARDL exhibits strong and reliable performance despite scarce data, making it well-suited for analyzing economic research with a small sample size. Also, the capacity to capture both short and long-term correlations between variables enables a thorough comprehension of the complex dynamics that drive economic processes (Sharma & Paramati, 2021).

Following the Adedoyin, & Zakari, (2020), this study employs a single regression model to analyze the nexus among energy usage, economic policy uncertainty, and economic growth. The generalized empirical models can be expressed as follows.

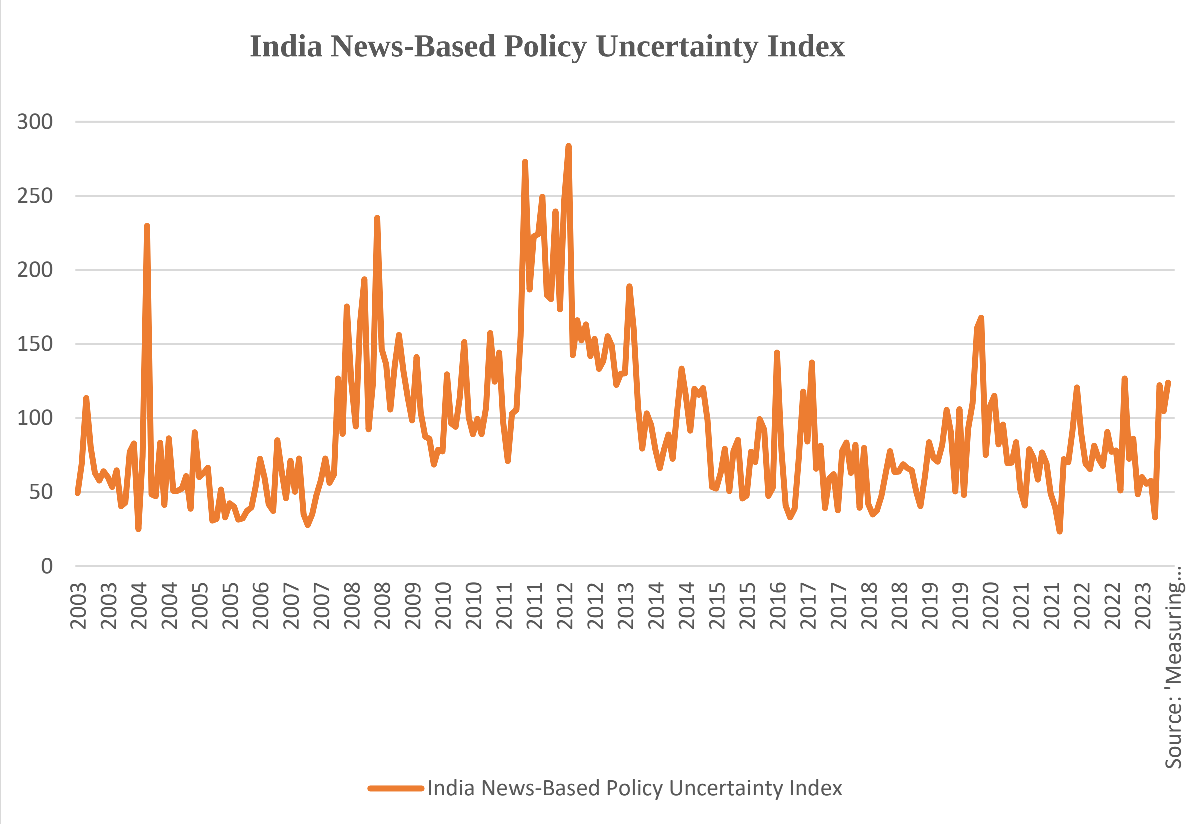
$$lnGDP_t = \beta_0 + \beta_1 lnEU_t + \beta_2 lnMVA_t + \beta_3 TO_t + \varepsilon t \quad (1)$$

$$lnGDP_t = \beta_0 + \beta_1 lnEU_t + \beta_2 lnEPU_t + \beta_3 lnMVA_t + \beta_4 TO_t + \varepsilon t \quad (2)$$

$$lnGDP_t = \beta_0 + \beta_1 lnEU_t + \beta_2 lnEPU_t + \beta_3 lnEU * EPU_t + \beta_4 lnMVA_t + \beta_5 TO_t + \varepsilon t \quad (3)$$

Where, β's are output elasticity energy consumption, economic policy uncertainty, interaction term (EPU*energy consumption), and supplementary potential variables. While subscripts t is the period and μ_t is the error term, respectively.

Figure 3. India News-Based Policy Uncertainty Index



Source: *Economic Policy Uncertainty Index*

3.2 Data and Descriptive Analysis

This paper's main aim is to discover the impact of EPU on energy-growth relationship, employing annual data for the empirical study from 1997 to 2022 for India. The selected time frame for this study depends on the data's availability, particularly the economic policy uncertainty index. The description of the data is provided in Table 1. GDP (constant 2010US$), energy use (EU) is proxied by primary energy consumption (kg of oil equivalent per capita), EPU proxied as economic policy uncertainty index, converted into annual frequency. Manufacturing, value added proxied as manufacturing, value added (% of GDP), and trade openness proxied as the ratio of imports plus exports to GDP (% of GDP). The pattern of EPU data for India (see Fig.3).

The description of the descriptive analysis (see Table 2) reports that economic growth (GDP), energy use (EU), EPU, renewable consumption (RC), non-renewable consumption (NRC), trade -openness (TO) and manufacturing value-added (MVA) are positively trending on average of 27.585,3.059, 6.951, 3.673, 8.587, 3.159 and 2.748 respectively. The skewness analysis reveals a negative skewness for all variables except for EPU and renewable usage. Conversely, the kurtosis values indicate that the variables under study exhibit a positive leptokurtic distribution.

Table 1: *Variable Description*

Variable	Notation	Definition	Source
Gross domestic product	GDP	GDP (constant 2010 US$)	World Development Indicator (WDI)
Energy use	EU	Energy use (kg of oil equivalent per capita)	World Development Indicator (WDI)
Economic policy uncertainty	EPU	Economic Policy Uncertainty Index	Economic Policy Uncertainty Index
Non- Renewable consumption	NRE	Fossil fuel energy consumption (% of total)	BP Statistical Review
Renewable consumption	RC	Renewable energy consumption (% of total final energy consumption)	BP Statistical Review
Manufacturing value added	MVA	Manufacturing, value added (% of GDP)	World Development Indicator
Trade Openness	TO	The ratio of imports plus exports to GDP (% of GDP)	World Development Indicator

*Author calculation

Table 2: Descriptive Statistics

	GDP	EU	EPU	RC	NRC	TO	MVA
Mean	27.858	3.059	6.951	3.673	8.587	3.159	2.748
Median	28.036	3.095	6.842	3.660	8.641	3.178	2.746
Minimum	26.754	2.460	6.387	3.483	8.010	3.068	2.648
Maximum	28.850	3.655	7.708	3.870	9.100	3.247	2.839
Standard Deviation	0.716	0.381	0.366	0.142	0.361	0.057	0.059
Skewness	-0.286	-0.088	0.329	0.074	-0.151	-0.235	-0.017
Kurtosis	1.612	1.603	2.197	1.419	1.572	1.656	2.229
Observations	26	26	26	26	26	26	26

4. Results and Discussion

4.1 Unit root

Prior to ARDL (Autoregressive Distributed Lag) method estimation, checking the stationarity of variables is essential, ensuring that selected variables must be either integrated at I (1) or both I (0), and I (1), respectively. Table 3 displays the unit-root test outcomes, crucial for verifying the data series' suitability for ARDL analysis. The Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests confirmed the presence of unit root except for energy use and EPU. However, the analysis based on the I (1) reject the null- hypothesis at a 1% level of significance, supporting the acceptance of the alternative hypotheses.

Table 3: Unit Root Results

	ADF	Phillips-Perron
@ level		
GDP	3.23	4.90
EU	1.19***	1.60**
EPU	2.02**	1.95**
TO	1.71	1.82
MVA		
@ First Difference		
GDP	5.68***	6.89***
EU	9.39***	15.10**
EPU	2.33***	6.60***
TO	7.72**	6.34***
MVA	4.00***	8.89***

*Note: 1%, 5% and 100% levels are indicated respectively by ***, ** and **

4.2 Bound test

Table 4 displays the results of the bound -test, indicating the existence of long-term equilibrium throughout the models. The F-statistic values surpass the upper thresholds of the t-statistic at (10%, /5%, and / 1% levels of significance, confirming the long-term cointegration of the data series.

Table 4: Bond test results

GDP=f (EU, TO, MVA)				
F-bounds test statistics		Null Hypothesis: No levels of relationships		
		Significance	I (0)	I (1)
F-statistic	9.601	10%	2.45	3.52
K	4	5%	2.86	4.01
		1%	3.74	5.06
GDP=f (EU, EPU, TO, MVA)				
F-bounds test statistics		Null Hypothesis: No levels of relationships		
		Significance	I (0)	I (1)
F-statistic	8.454	10%	2.26	3.35
K	5	5%	2.62	3.79
		1%	3.41	4.68

*GDP=f (EU, TO, EPU, EU*EPU, MVA)*

F-bounds test statistics			Null Hypothesis: No levels of relationships		
			Significance	I (0)	I (1)
F-statistic	6.923		10%	2.12	3.23
K	6		5%	2.45	3.61
			1%	3.15	4.43

4.3 ARDL results

The autoregressive distributed lag (ARDL) results documented in Table 5 confirmed that average energy usage (1.868%) positively impacts economic growth (GDP). Since energy is a significant factor in economic activity, the need for energy activities escalates as economies expand. Energy growth engenders a surge in energy consumption as industries proliferate, and the need for energy-intensive activities acts as a fundamental catalyst for industrial activities that enhance productivity and contribute to increased industrial output (Raza et al., 2021; Salari et al., 2020). Similarly,1% increments in trade openness and manufacturing value-added led to increases of 0.290% and 0.190 % in economic growth in India. Furthermore, trade openness and manufacturing value-added enhance growth by facilitating efficient specialization and encouraging competitive advantages. Moreover, a country's manufacturing sector catalyzes technological progress and innovation (Vo et al., 2019).

Regarding the short-term analysis, the ECM coefficient aligns with expectations, exhibiting a negative value of -0.851. Short-term estimation reveals that previous GDP values positively impact GDP, leading to a reduction of 0.340% in this variable. Conversely, current energy use values strongly influence GDP, contributing to a growth increase of 0.103%. The results for model 2 confirm that energy consumption, trade openness, and manufacturing value-added significantly influence GDP by 1.499%, 0.541%, and 0.220% per year, respectively.

By contrast, in the long run, economic policy uncertainty adversely influences GDP, resulting in a 0.275% decrease in GDP. Similar results are discovered from past research (Ayad et al., 2022; Farooq et al., 2022; Wang et al., 2014).EPU often discourage businesses from committing to long-term investments. Thus, it impedes innovation research and development. Firms opt to postpone or scale back capital expenditure due to concerns about unpredictable government policies, uncertain regulatory environments, or unpredictable economic conditions. In addition, economic policy uncertainty contributes to increased fluctuations in financial markets, which heightened instability and makes investors and businesses more risk-averse, fostering a reluctance to engage in economic activities (Adams et al., 2020; Bhagat et al., 2016; Wang et al., 2020). Short-term stability is indicated by a negative Error Correction Term (ECT) score of -0.425, significant with a confidence level of 99%. The results further verify that the previous GDP value impacts its growth, leading to an annual increase of 0.453%. Energy usage and trade openness positively contributed to economic growth, with an average impact of 0.125% and 1.295%.

Furthermore, model 3 in Table 5 shows that energy use, trade openness, and manufacturing value-added positively impact GDP by 17.510%, 0.620%, and 0.362%, respectively. However, the coefficient of EPU negatively impacted GDP (0.0822%). Additionally, EPU moderates (12.28%) the relationship between energy-growth nexus. As EPU rises, policymakers may shift their focus towards promoting economic growth at the expense of environmental protection by utilizing less expensive fossil fuels, reflecting a prioritization of economic consideration (Farooq et al., 2022). Moreover, short-term results show that previous GDP values lead to a

0.560% growth in GDP. Similarly, economic policy uncertainty significantly reduces GDP levels by 0.285% annually. In addition, both energy use and interaction term EPU*EU positively affect economic growth, with 0.349% and 9.265%, respectively.

Table 5: ARDL results

Variables	**Model -1**	**Model -2**	**Model- 3**
Long run results			
EU	1.868***	1.499**	17.510**
	0.187	0.475	7.690
EPU		-0.275**	-8.032***
		0.247	11.410
EU*EPU			12.28**
			74.61
TO	0.290**	0.541**	0.620***
	1.163	3.245	17.68
MVA	0.192**	0.220**	0.392**
	-0.35	-1.064	-3.694
Short Run results			
ECT	-0.851**	-0.425***	-0.229***
	0.251	0.280	0.295
D.GDP	0.340**	0.453*	0.560**
	0.190	0.245	0.345
D. EU	0.103**	0.125***	0.349***
	0.557	0.492	2.195
D. TO	0.539**	1.298***	1.069
	1.026	0.984	1.117
D. MVA	0.448***	0.463	0.491***
	-0.39	0.358	0.361
D.EPU		-0.130***	-0.285**
		0.037	0.966
D.EU*EPU			9.265**
			6.669
Constant	13.51*	3.449**	13.101**
	4.869	5.83	9.143
Observations	25s	25	25
R-square	0.581	0.720	0.809
CUSM	Stable	Stable	Stable
CUSM Square	Stable	Stable	Stable

*Standard errors in parentheses * p<0.05, ** p<0.01, *** p<0.001*

In the last analysis, we conducted the Toda and Yamamoto causality test (see Table 6). The results disclose heterogeneous results for India. Energy use has one- way link with economic growth, i.e. supporting the growth hypothesis in India. However, Economic policy uncertainty exhibits a uni-directional link between economic growth and energy use. Accordingly, regression results are supported by the causality that energy usage is crucial for economic growth in a developing country like India. Furthermore, the one-way causality from EPU to both energy use and economic growth supports that EPU in India induces cheap energy use to boost economic growth, which can offset the cascading effect of EPU in the long run.

Table -6: Granger Causality

Variables	**Toda & Yamamoto test**	**Causality**
Economic growth- Energy use	5.690 (0.231)	Not exist
Energy use - Economic growth	17.890(0.032) ***	Exist
EPU-Energy use	5.456(0.001) ***	Exist
Energy use - EPU	6.786 (0.234)	Not exist
EPU -Economic growth	1.234(0.037) **	Exist
Economic growth-EPU	3.234 (0.134)	Not exist

4.4 Robustness analysis

As a first robustness, this study utilized the alternative proxies to support the creditability of baseline results. Following (Fatai et al., 2021; K. Khan & Su, 2022; Korkut et al., 2023), energy use is re-estimated using renewable and non-renewable energy usage as a substitute for energy usage, which indicated that the estimated values for both energy proxies remained significant and displayed the same patterns as those reported in the baseline regression results (See table 7). This consistency of alternative proxy results supports the validity and robustness of the baseline regression, thereby strengthening the study's findings.

Table 7: ARDL results

	Model -1	Model -2
Long-run results		
Non-Renewable Consumption	0.597**	
	3.496	
Non-Renewable cons.*EPU	0.698***	
	0.449	
Renewable Consumption		17.820*
		-7.001
Renewable Consumption *EPU		-2.702*
		0.975
Economic Policy Uncertainty	-0.403**	0.346
	3.982	3.501
Trade Openness	0.581**	10.49***
	3.224	-1.950
MVA	0.581**	0.696**
	0.709	1.608

Short run results		
ECT	-3.848	-0.347*
	-0.235	-0.161
D. Fossil cons.	0.491***	
	1.003	
D. fossil cons.*EPU	-0.269**	
	0.149	
D. renewable Cons.		0.602**
		2.973
D. renewable *EPU		0.587***
		0.391
D.TO	0.387**	0.423***
	0.981	1.091
D. Mva	0.439*	0.507*
	-0.352	-0.390
Constant	23.17	-23.76*
	-10.73	-9.375
Observation	25	25
R-square	0.792	0.771
CUSM	Stable	Stable
CUSM Square	Stable	Stable

*Note: Standard errors in parentheses * p<0.05, ** p<0.01, *** p<0.001*

4.4.1 Predictive Analytics Using Machine Learning Techniques

Past studies have used traditional methods to determine the relevant antecedents for prediction purposes. However, machine learning techniques are widely used in various domains, including finance, healthcare, marketing, economics, and so on, to solve real-life problem statements. In this work, we have used machine learning techniques, including multiple linear regression (MLR), random forest regressor (RFR), and gradient boost regressor (GBR) to predict the GDP based on the predicate variables. The dataset was used to train and test the considered models with hyperparameters to achieve better prediction results. We considered the following three machine-learning algorithms:

a) MLR is a statistical/machine learning method used to identify the relationship among the dataset's variables, particularly between two or more independent variables (predictors) and a dependent variable. The general form of multiple linear regression can be expressed mathematically by Eq. (4).

$$Y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \ldots \ldots \ldots . \beta_n x_n + \varepsilon \qquad (4)$$

where Y is the dependent variable, β is the intercept, and $\beta_1, \beta_2, \beta_3 \ldots\ldots\ldots \beta_n$ are the coefficients. Also, x_1, x_2, $x_3 \ldots\ldots\ldots x_n$ are independent variables, and ε is the error term between the actual and predicted value of Y.

b) RFR Model: The Random Forest algorithm is used for classification and regression tasks in machine learning. It consists of numerous decision trees, pooling and synthesizing outcomes from various trees to produce the final prediction. One of its key strengths lies in its ability to mitigate overfitting by employing grid search to identify optimal hyperparameters, ensuring the construction of robust models. The prediction of the RFR model is presented mathematically by Eq. 5.

$$Y(x) = \frac{1}{T}\sum_{t=1}^{T} f_t(x) \qquad (5)$$

Here, $Y(x)$ is the predicted output for input x, T denotes the number of decision trees, and $f_t(x)$ is the prediction of the *t-th* decision tree.

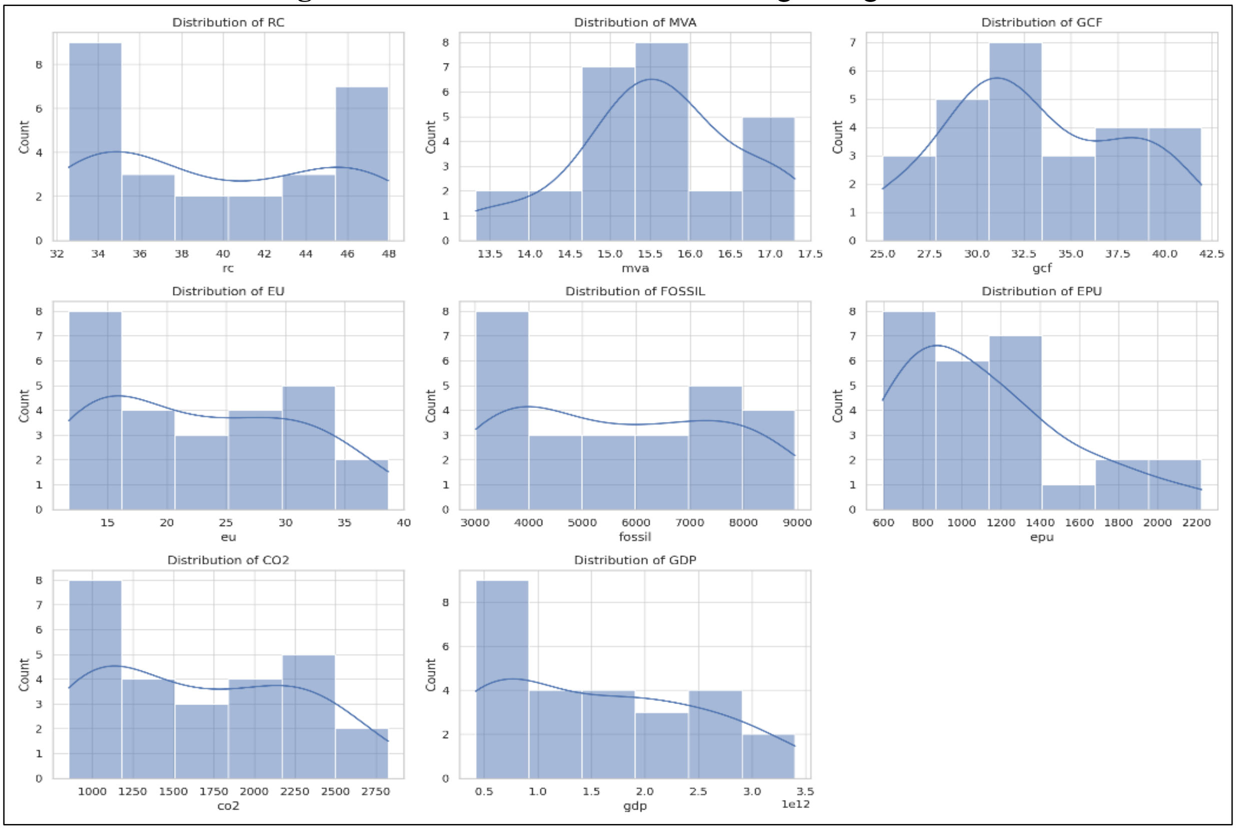
c) GBR: This approach involves training weak learners sequentially, gradually incorporating each estimator by adjusting their weights. The gradient boosting algorithm primarily predicts the residual errors of preceding estimators and endeavours to minimize the disparity between predicted and actual values. The objective function for the gradient boosting algorithm is expressed by Eq. 6.

$$L(\theta) = min_F \sum_{i=1}^{N} l(y_i\,, Fmathbf(x_i)) \qquad (6)$$

where F is the ensemble model, n is the number of training examples, y_i is the true label of the i^{th} sample, l denotes the loss function, and $Fmathbf(x_i)$ is the output of the ensemble model on example $mathbf(x_i)$.

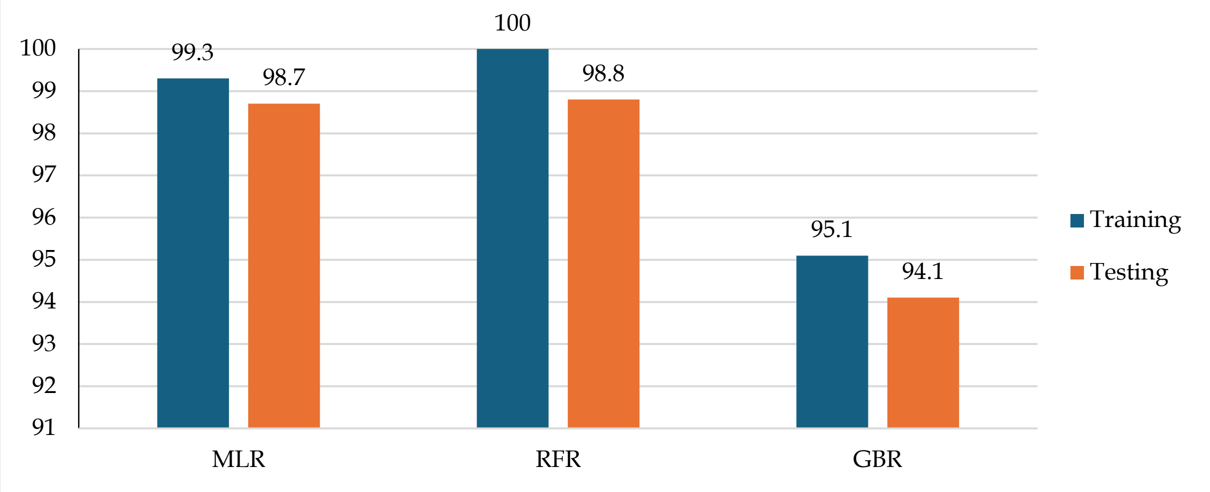
Histograms serve as a tool for visualizing and understanding the distribution of data samples. They can exhibit patterns such as uniform, normal, left-skewed, or right-skewed distributions. Figure 4 usually presents distributed histograms, organizing all attributes within their respective value ranges. The x-axis denotes the nature of the attribute, while the y-axis illustrates the attribute's values.

Fig 4: Distribution of the variables using histogram.



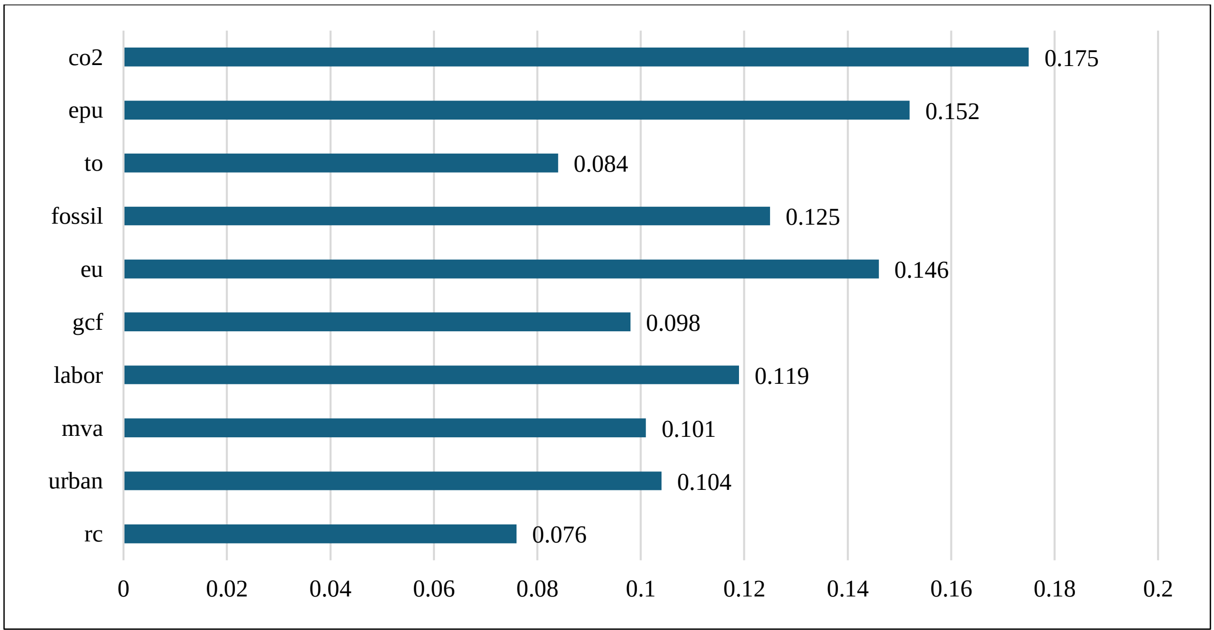
The training and testing accuracy of the considered models are shown in Figure 5. Among all the models, RFR achieved the highest accuracy rate of 100% and 98.80% for training and testing, respectively. It also attained the lowest error metrics (MAE, MSE, RMSE), indicating the best predictive models for GDP prediction. While the GBR model achieved the lowest accuracy rate of 95. 10% and 94.10% for training and testing, respectively.

Fig 5: Training and testing accuracies of the considered model.



To calculate the predicate variables' contribution towards the GDP prediction, we employed the Feature Significance Score (F1-score). Figure 6 illustrates the contributions of each predictor variable to GDP prediction. Notably, carbon emissions (CO2), economic policy uncertainty (EPU), and energy use (EU) emerge as the most influential factors. In contrast, other factors, such as renewable consumption (RC) and trade openness (TO), are the least contributors to GDP prediction. Notably, none of the variables exhibits zero contribution across all algorithms. Hence, no feature elimination was made.

Fig 6: Contribution of predicate variables towards the prediction of GDP



5. Discussion and Conclusion

Examining the connection between EPU, energy usage, and economic growth in India provides new perspectives on environmental policy for developing economies. This paper studies how economic policy uncertainty impacts the energy-growth relationship, using ARDL methodology from 1997-2022 to ascertain the long-run relationship and ECT for the short-run relationship. Furthermore, this study employs machine learning (ML) techniques, Multiple linear regression (MLR), Radom Forest Regressor (RFR), and Gradient Boosting Regressor (GBR) to predict GDP based on various predictor variables. These results support that EPU is negatively related to GDP growth in both the short /long run. The reluctance of investors and businesses to make substantial commitments amidst uncertain policy environments led to delayed investments and decreased consumer confidence.

Additionally, energy usage primarily induces Indian economic growth, indicative of its role in fostering industrial activities and productivity. Moreover, EPU moderated the relationship energy-growth nexus, suggesting that using affordable fossil energy as a strategic way to lift economic growth via enhancing productivity and industrial operations can offset the adverse impact of EPU. Additionally, the results from the causality test confirm that energy use induces economic growth in India and further confirm the one-way causality from EPU to economic growth and energy use. Moreover, Feature significance (F1-score) is used to assess the contribution of predictor variables to GDP prediction. The results demonstrate that only carbon emission, economic policy uncertainty and energy use emerge as influential factors. Considering these findings, Indian policymakers can boost energy security and mitigate the adverse effects by aggressively encouraging and shifting towards clean energy sources. This strategic energy transition can help accomplish SDG7, promote an environmentally friendly business environment, and attract foreign investments, reinforcing India's standing in the worldwide shift towards clean energy. Additionally, policymakers should actively work towards minimizing uncertainty by anticipating potential changes in the regulatory policy, e.g., environment, fiscal and monetary policies towards promoting sustainable development SDG-8.

This study, while providing valuable insights into the EPU-energy-growth nexus in India, is subject to certain limitations. The reliance on aggregate national-level data may mask regional heterogeneities and variations in energy consumption patterns. Furthermore, the study's scope, focusing primarily on linear relationships, may not fully capture the complexities of the interplay between these variables. Future research could explore these dynamics at a disaggregated level, potentially incorporating nonlinear modeling techniques and considering the role of specific policy interventions. Investigating the impact of different types of EPU (e.g., related to trade, fiscal policy, or environmental regulations) on the energy-growth nexus would also be a valuable extension. Finally, comparative studies with other developing economies could offer broader perspectives and identify best practices for navigating the challenges of EPU and achieving sustainable development goals.

References:

Abbasi, K. R., & Adedoyin, F. F. (2021). Do energy use and economic policy uncertainty affect CO 2 emissions in China ? Empirical evidence from the dynamic ARDL simulation approach. 23323–23335.

Acheampong, A. O., Boateng, E., Amponsah, M., & Dzator, J. (2021). Revisiting the economic growth–energy consumption nexus: Does globalization matter? Energy Economics, 102(December 2020), 105472. https://doi.org/10.1016/j.eneco.2021.105472

Adams, S., Adedoyin, F., Olaniran, E., & Victor, F. (2020). Energy consumption , economic policy uncertainty and carbon emissions ; causality evidence from resource rich economies. Economic Analysis and Policy, 68, 179–190. https://doi.org/10.1016/j.eap.2020.09.012

Adebayo, T. S. (2021). Can CO 2 emissions and energy consumption determine the economic performance of South Korea ? A time series analysis. 38969–38984.

Adedoyin, F. F., & Zakari, A. (2020). Energy Consumption, Economic Expansion, and CO2 Emission in the UK: The Role of Economic Policy Uncertainty. Science of the Total Environment, 738, 14001, 1–45.

Adedoyin, F. F. (2021). An investigation into the anthropogenic nexus among consumption of energy , tourism , and economic growth : do economic policy uncertainties matter ? 2835–2847.

Ahmad, A., Zhao, Y., Shahbaz, M., Bano, S., Zhang, Z., Wang, S., & Liu, Y. (2016). Carbon emissions, energy consumption and economic growth: An aggregate and disaggregate analysis of the Indian economy. Energy Policy, 96(March 2019), 131–143. https://doi.org/10.1016/j.enpol.2016.05.032

Ahmed, Z. (2019). Investigating the impact of human capital on the ecological footprint in India : An empirical analysis. 26782–26796.

Al-mulali, U., & Che Sab, C. N. B. (2018). The impact of coal consumption and CO2emission on economic growth. Energy Sources, Part B: Economics, Planning and Policy, 13(4), 218–223. https://doi.org/10.1080/15567249.2012.661027

Al-thaqeb, S. A., & Ghanim, B. (2019). The Journal of Economic Asymmetries Economic policy uncertainty : A literature review. The Journal of Economic Asymmetries, 20(July), e00133. https://doi.org/10.1016/j.jeca.2019.e00133

Alper, A., & Oguz, O. (2016). The role of renewable energy consumption in economic growth : Evidence from asymmetric causality. Renewable and Sustainable Energy Reviews, 60, 953–959. https://doi.org/10.1016/j.rser.2016.01.123

Alshehry, A. S., & Belloumi, M. (2015). Energy consumption, carbon dioxide emissions and economic growth: The case of Saudi Arabia. Renewable and Sustainable Energy Reviews, 41, 237–247. https://doi.org/10.1016/j.rser.2014.08.004

Anser, M. K., Syed, Q. R., Lean, H. H., Alola, A. A., & Ahmad, M. (2021). Do Economic Policy Uncertainty and Geopolitical Risk Lead to Environmental Degradation ? Evidence from Emerging Economies.

Apergis, E., Apergis, N., & Apergis, E. (2021). The impact of COVID-19 on economic growth : evidence from a Bayesian Panel Vector Autoregressive (BPVAR) model ABSTRACT. Applied Economics, 53(58), 6739–6751. https://doi.org/10.1080/00036846.2021.1946479

Apergis, N., & Foon, C. (2013). Is the energy-led growth hypothesis valid ? New evidence from a sam- ple of 85 countries. Energy Economics, 38, 24–31. https://doi.org/10.1016/j.eneco.2013.02.007

Ayad, H., Eddin, S., Hassoun, S., Usman, M., & Ahmad, P. (2022). The impact of economic uncertainty , economic growth and energy consumption on environmental degradation in MENA countries : Fresh insights from multiple thresholds NARDL approach. 0123456789. https://doi.org/10.1007/s11356-022-22256-w

Baker, S. R., Bloom, N., Davis, S. J., Boehnke, J., Dashkeyev, V., Deriy, O., Dinh, E., Ezure, Y., Gong, R., Kim, R., Klosin, S., Koh, J., Lajewski, P., Nebiyu, D., Sachs, R., Shibata, I., Stephenson, C., Takeda, N., Tan, M., … Kashyap, A. (2016). Measuring Economic Policy Uncertainty. March.

Baker, S. R., Bloom, N., Davis, S. J., Dashkeyev, V., Deriy, O., Dinh, E., Ezure, Y., Gong, R., Jindal, S., Kim, R., Klosin, S., Koh, J., Lajewski, P., Sachs, R., Shibata, I., Stephenson, C., & Takeda, N. (2016). OF ECONOMICS. 131(November), 1593–1636. https://doi.org/10.1093/qje/qjw024.Advance

Baz, K., Xu, D., Minua, G., Ampofo, K., Ali, I., Khan, I., Cheng, J., & Ali, H. (2019). Energy consumption and economic growth nexus : New evidence from Pakistan using asymmetric analysis. xxxx.

Behera, J. (2015). Examined the energy-led growth evidence from time series analysis *hypothesis in India: Contribution / Originality. 2(4), 46–65. https://doi.org/10.18488/journal.82/2015.2.4/82.4.46.65*

Belloumi, M. (2015). Investigating the causal relationship between transport infrastructure , transport energy consumption and economic growth in Tunisia. October. https://doi.org/10.13140/RG.2.1.2310.7040

Bhagat, S., Ghosh, P., & Rangan, S. (2016). Economic Policy Uncertainty and Growth in India. 51(35), 72–81.

Bhattacharya, S., Bhattacharya, M., & Rafi, S. (2015). The role of technology on the dynamics of coal consumption – economic growth : New evidence from China Related papers.

Bhowmik, R., Syed, Q. R., & Apergis, N. (2022). Applying a dynamic ARDL approach to the Environmental Phillips Curve (EPC) hypothesis amid monetary , fiscal , and trade policy uncertainty in the USA. 14914–14928.

Bildirici, M. E., & Bakirtas, T. (2014). The relationship among oil, natural gas and coal consumption and economic growth in BRICTS (Brazil, Russian, India, China, Turkey and South Africa) countries. Energy, 65, 134–144. https://doi.org/10.1016/j.energy.2013.12.006

Bloom, N. (2009). THE IMPACT OF UNCERTAINTY SHOCKS.

Bonaime, A., Gulen, H., & Ion, M. (2018). Does policy uncertainty affect mergers and acquisitions? Journal of Financial Economics, 129(3), 531–558. https://doi.org/10.1016/j.jfineco.2018.05.007

Bordo, M. D., & Meissner, C. M. (2009). FOREIGN CURRENCY DEBT, FINANCIAL CRISES AND ECONOMIC GROWTH: A LONG RUN VIEW.

Caggiano, G., Castelnuovo, E., & Manuel, J. (2017). Economic policy uncertainty and unemployment in the United States : A nonlinear approach. Economics Letters, 151, 31–34. https://doi.org/10.1016/j.econlet.2016.12.002

Carfora, A., Pansini, R. V., & Scandurra, G. (2019). The causal relationship between energy consumption, energy prices and economic growth in Asian developing countries: A replication. Energy Strategy Reviews, 23(December 2018), 81–85. https://doi.org/10.1016/j.esr.2018.12.004

Chandran Govindaraju, V. G. R., & Tang, C. F. (2013). The dynamic links between CO2 emissions, economic growth and coal consumption in China and India. Applied Energy, 104, 310–318. https://doi.org/10.1016/j.apenergy.2012.10.042

Chaudhary, M., Sodani, P. R., & Das, S. (2020). Effect of COVID-19 on Economy in India : Some Reflections for Policy and Programme. https://doi.org/10.1177/0972063420935541

Chukwudi, M., & Edwin, U. (2022). Investigating the moderating role of economic policy uncertainty in environmental Kuznets curve for South Africa : Evidence from the novel dynamic ARDL simulations approach. In Environmental Science and Pollution Research. Springer Berlin Heidelberg. https://doi.org/10.1007/s11356-022-21107-y

Čižmešija, M., Lolić, I., & Sorić, P. (2017). Economic policy uncertainty index and economic activity: What causes what? Croatian Operational Research Review, 8(2), 563–575. https://doi.org/10.17535/crorr.2017.0036

Countries, S. A. (2009). FDI , Growth and the Asian Financial Crisis : The Experience of. February 2007, 22–23. https://doi.org/10.1111/j.1467-9701.2009.01202.x

Danish, Zhang, B., Wang, Z., & Wang, B. (2018). Energy production, economic growth and CO2 emission: evidence from Pakistan. Natural Hazards, 90(1), 27–50. https://doi.org/10.1007/s11069-017-3031-z

Demir, E., & Ersan, O. (2017). Economic policy uncertainty and cash holdings: Evidence from

BRIC countries. Emerging Markets Review, 33, 189–200. https://doi.org/10.1016/j.ememar.2017.08.001

Destek, M. A. (2016). Renewable energy consumption and economic growth in newly industrialized countries: Evidence from asymmetric causality test. Renewable Energy, 95, 478–484. https://doi.org/10.1016/j.renene.2016.04.049

Doğan, E., & Güler, C. (2021). How economic policy uncertainty affect carbon emissions: A case of G-7 countries. Journal of Economics and Business Issues, 1(1), 33-38.

Erzurumlu, Y. O., & Gozgor, G. (2022). Effects of economic policy uncertainty on energy demand : evidence from 72 countries. Journal of Chinese Economic and Business Studies, 20(1), 23–38. https://doi.org/10.1080/14765284.2021.2009999

Fang, Z., & Chang, Y. (2016). Energy, human capital and economic growth in Asia Pacific countries—Evidence from a panel cointegration and causality analysis. Energy Economics, 56, 177-184.

Farooq, U., Gillani, S., Haider, B., Muhammad, S., & Shafiq, N. (2022). Economic policy uncertainty and environmental degradation : the moderating role of political stability. Environmental Science and Pollution Research, 0123456789. https://doi.org/10.1007/s11356-022-23479-7

Fatai, F., Ozturk, I., Oluwatoyin, M., Agboola, P. O., & Victor, F. (2021). The implications of renewable and non-renewable energy generating in Sub-Saharan Africa : The role of economic policy uncertainties. Energy Policy, 150(December 2020), 112115. https://doi.org/10.1016/j.enpol.2020.112115

Foon, C., Wah, B., & Ozturk, I. (2016). Energy consumption and economic growth in Vietnam. Renewable and Sustainable Energy Reviews, 54, 1506–1514. https://doi.org/10.1016/j.rser.2015.10.083

Ghosh, S., & Kanjilal, K. (2014). Long-term equilibrium relationship between urbanization, energy consumption and economic activity: Empirical evidence from India. Energy, 66, 324–331. https://doi.org/10.1016/j.energy.2013.12.052

Gilchrist, S., Sim, J. W., & Zakrajšek, E. (2014). Uncertainty, financial frictions, and investment dynamics (No. w20038). National Bureau of Economic Research.

Gu, X., Cheng, X., Zhu, Z., & Deng, X. (2021). Economic policy uncertainty and China's growth-at-risk. Economic Analysis and Policy, 70(16), 452–467. https://doi.org/10.1016/j.eap.2021.03.006

Gupta, G. (2022). CEO's educational background, economic policy uncertainty and investment-cash flow sensitivity: evidence from India. Applied Economics, 54(5), 568–579. https://doi.org/10.1080/00036846.2021.1967279

Hussain, H. I., Salem, M. A., Rashid, A. Z. A., & Kamarudin, F. (2019). Environmental impact of sectoral energy consumption on economic growth in malaysia: Evidence from ARDL bound testing approach. Ekoloji, 28(107), 199–210.

Jiang, Y. (2018). visiting the economic policy uncertainty shocks - economic growth relationship: wavelet- based granger-causality in quantiles approach. 2, 80–94.

Jin, X., Chen, Z., & Yang, X. (2019). Economic policy uncertainty and stock price crash risk. Accounting and Finance, 58(5), 1291–1318. https://doi.org/10.1111/acfi.12455

Khan, I., Hou, F., Irfan, M., Zakari, A., & Phong, H. (2021). Does energy trilemma a driver of economic growth ? The roles of energy use , population growth , and financial development. Renewable and Sustainable Energy Reviews, 146(April), 111157. https://doi.org/10.1016/j.rser.2021.111157

Khan, K., & Su, C. W. (2022). Does policy uncertainty threaten renewable energy? Evidence from G7 countries. Environmental Science and Pollution Research, 29(23), 34813-34829.

Khanh, L., Buhari, C., Emmanuel, D., Aikins, J., Sudeshna, A., & Mesut, G. (2022). Impact of *economic policy uncertainty , geopolitical risk , and economic complexity on carbon emissions and ecological footprint : an investigation of the E7 countries. Environmental Science and Pollution Research, 0123456789. https://doi.org/10.1007/s11356-022-24682-2*

Kongkuah, M., Yao, H., & Yilanci, V. (2021). The relationship between energy consumption , economic growth , and - CO 2 emissions in China : the role of urbanization and international trade. Environment, Development and Sustainability, 0123456789. https://doi.org/10.1007/s10668-021-01628-1

Korkut, U., Adewale, A., Erdogan, S., & Kartal, T. (2023). The influence of income , economic policy uncertainty , geopolitical risk , and urbanization on renewable energy investments in G7 countries United States of America. Energy Economics, 128(October), 107172. https://doi.org/10.1016/j.eneco.2023.107172

Lei, Y., Li, L., & Pan, D. (2014). Study on the relationships between coal consumption and economic growth of the six biggest coal consumption countries : with coal price as a third variable. 61, 624–634. https://doi.org/10.1016/j.egypro.2014.11.1185

Li, R., & Leung, G. C. K. (2012). Coal consumption and economic growth in China. Energy Policy, 40(1), 438–443. https://doi.org/10.1016/j.enpol.2011.10.034

Lin, F. L., Inglesi-Lotz, R., & Chang, T. (2018). Revisit coal consumption, CO2 emissions and economic growth nexus in China and India using a newly developed bootstrap ARDL bound test. Energy Exploration and Exploitation, 36(3), 450–463. https://doi.org/10.1177/0144598717741031

Marion, J. A. N. (1991). POLICY UNCERTAINTY, PERSISTENCE AND GROWTH.

Menon, B. G., Sahadev, S., & Mahanty, A. (2023). Trivariate causality between economic growth , energy consumption , and carbon emissions : empirical evidence from India. Energy Efficiency. https://doi.org/10.1007/s12053-023-10118-4

Odugbesan, J. A., & Rjoub, H. (2020). Relationship Among Economic Growth, Energy Consumption, CO2 Emission, and Urbanization: Evidence From MINT Countries. SAGE Open, 10(2). https://doi.org/10.1177/2158244020914648

Ohlan, R. (2016). Renewable and nonrenewable energy consumption and economic growth in India. Energy Sources, Part B: Economics, Planning and Policy, 11(11), 1050–1054. https://doi.org/10.1080/15567249.2016.1190801

Omri, A. (2017). An international literature survey on energy-economic growth nexus : Evidence from country-specific studies An international literature survey on energy-economic growth nexus : Evidence from country-specific studies. 82452, 0–23.

Ozcan, B., & Ozturk, I. (2019). Renewable energy consumption-economic growth nexus in emerging countries: A bootstrap panel causality test. Renewable and Sustainable Energy Reviews, 104(January), 30–37. https://doi.org/10.1016/j.rser.2019.01.020

Park, S. Y., & Yoo, S. H. (2014). The dynamics of oil consumption and economic growth in Malaysia. Energy Policy, 66, 218–223. https://doi.org/10.1016/j.enpol.2013.10.059

Pejović, B., Karadžić, V., Dragašević, Z., & Backović, T. (2021). Economic growth , energy consumption and CO 2 emissions in the countries of the European Union and the Western Balkans. Energy Reports, 7, 2775–2783. https://doi.org/10.1016/j.egyr.2021.05.011

Phan, H. V., Nguyen, N. H., Nguyen, H. T., & Hegde, S. (2019). Policy uncertainty and firm cash holdings. Journal of Business Research, 95(September 2018), 71–82. https://doi.org/10.1016/j.jbusres.2018.10.001

Phukon, M. A., & Konwar, M. M. (2019). An Empirical Investigation of the Causal Relationship amongst Energy Consumption, Net Fixed Capital Stock and

Economic Growth in India. The International Journal of Social Sciences and Humanities Invention, 6(5), 5449–5454. https://doi.org/10.18535/ijsshi/v6i5.08

Qamruzzaman, M. (2022). Nexus between Economic Policy Uncertainty and Institutional Quality: Evidence from Indian and Pakistan. Macroeconomics and Finance in Emerging Market Economies, 00(00), 1–20. https://doi.org/10.1080/17520843.2022.2026035

Rahman, M., & Velayutham, E. (2020). Renewable and non-renewable energy consumption-economic growth nexus: New evidence from South Asia. Renewable Energy, 147(2020), 399–408. https://doi.org/10.1016/j.renene.2019.09.007

Rani, R., & Kumar, N. (2019). Investigating the Presence of Environmental Kuznets Curve Hypothesis in India and China: An Autoregressive Distributive Lag Approach. Jindal Journal of Business Research, 8(2), 194–210. https://doi.org/10.1177/2278682119880510

Raza, K., Shahbaz, M., Jiao, Z., & Tufail, M. (2021). How Energy Consumption , Industrial Growth , Urbanization , and CO2 Emissions Affect Economic Growth in Pakistan ? A Novel Dynamic ARDL Simulations Approach How energy consumption , industrial growth , urbanization , and CO 2 emissions affect economic gro. Energy, 221(January), 119793. https://doi.org/10.1016/j.energy.2021.119793

Rehman, E., & Rehman, S. (2022). Modeling the nexus between carbon emissions , urbanization , population growth , energy consumption , and economic development in Asia : Evidence from grey relational analysis. Energy Reports, 8, 5430–5442. https://doi.org/10.1016/j.egyr.2022.03.179

Ren, Y., Guo, Q., Zhu, H., & Ying, W. (2020). The effects of economic policy uncertainty on China's economy: evidence from time-varying parameter FAVAR. Applied Economics, 52(29), 3167–3185. https://doi.org/10.1080/00036846.2019.1707475

Salari, M., Javid, R. J., & Noghanibehambari, H. (2020). The nexus between CO2 emissions, energy consumption, and economic growth in thUS Economic Analysis and Policy. https://doi.org/10.1016/j.eap.2020.12.007

Salisu, A. A., & Ogbonna, A. E. (2019). Another look at the energy-growth nexus: New insights from MIDAS regressions. Energy, 174, 69-84.

Shaari, M. S., Hussain, N. E., & Ismail, M. S. (2013). Relationship between Energy Consumption and Economic Growth : Empirical Evidence for Malaysia. Business System Review, 2(1). https://doi.org/10.7350/BSR.B02.2013

Shahbaz, M., Raghutla, C., Chittedi, K. R., Jiao, Z., & Vo, X. V. (2020). The effect of renewable energy consumption on economic growth: Evidence from the renewable energy country attractive index. Energy, 207, 118162. https://doi.org/10.1016/J.ENERGY.2020.118162

Sharma, C., & Paramati, S. R. (2021). Does economic policy uncertainty dampen imports? Commodity-level evidence from India. Economic Modelling, 94(September 2020), 139–149. https://doi.org/10.1016/j.econmod.2020.09.019

Shastri, S., Mohapatra, G., & Giri, A. K. (2020). Economic growth, renewable and nonrenewable energy consumption nexus in India: Evidences from nonlinear ARDL approach and asymmetric causality analysis. International Journal of Energy Sector Management, 14(4), 777–792. https://doi.org/10.1108/IJESM-06-2019-0016

Ssebabi, G., Odongo, T., & Francis, N. (2021). A survey of literature on energy consumption and economic growth. Energy Reports, 7, 9150–9239. https://doi.org/10.1016/j.egyr.2021.10.107

Su, C., Huang, S., Qin, M., & Umar, M. (2021). Does crude oil price stimulate economic policy uncertainty in BRICS ? Pacific-Basin Finance Journal, 66(September 2020), *101519. https://doi.org/10.1016/j.pacfin.2021.101519*

Udi, J., Bekun, F. V., & Adedoyin, F. F. (2020). Modeling the nexus between coal consumption, FDI inflow and economic expansion: does industrialization matter in South Africa? Environmental Science and Pollution Research, 27(10), 10553–10564. https://doi.org/10.1007/s11356-020-07691-x

Usman, M., Kousar, R., Makhdum, M. S. A., Yaseen, M. R., & Nadeem, A. M. (2022). Do financial development, economic growth, energy consumption, and trade openness contribute to increase carbon emission in Pakistan? An insight based on ARDL bound testing approach. Environment, Development and Sustainability, 0123456789. https://doi.org/10.1007/s10668-021-02062-z

Victor, F., & Asumadu, S. (2019). Science of the Total Environment Another look at the relationship between energy consumption , carbon dioxide emissions , and economic growth in South Africa. 655, 759–765. https://doi.org/10.1016/j.scitotenv.2018.11.271

Vo, Vo, & Le. (2019). CO2 Emissions, Energy Consumption, and Economic Growth: New Evidence in the ASEAN Countries. Journal of Risk and Financial Management, 12(3), 145. https://doi.org/10.3390/jrfm12030145

Waleed, A., Akhtar, A., & Pasha, A. T. (2018). Oil consumption and economic growth: Evidence from Pakistan. Energy Sources, Part B: Economics, Planning and Policy, 13(2), 103–108. https://doi.org/10.1080/15567249.2017.1354100

*Wang, C., & Cao, Y. (2021). Forecasting Chinese economic growth , energy consumption , and urbanization using two novel grey multivariable forecasting models *. Journal of Cleaner Production, 299, 126863. https://doi.org/10.1016/j.jclepro.2021.126863*

Wang, Q., Xiao, K., & Lu, Z. (2020). Does economic policy uncertainty affect CO2 emissions? Empirical evidence from the United States. Sustainability, 12(21), 9108.

Wang, Y., Chen, C. R., & Sophie, Y. (2014). Economic policy uncertainty and corporate investment : Evidence from China ☆. Pacific-Basin Finance Journal, 26, 227–243. https://doi.org/10.1016/j.pacfin.2013.12.008

Wei, W., Hu, H., & Chang, C. P. (2021). Economic policy uncertainty and energy production in China. Environmental Science and Pollution Research, 28(38), 53544-53567.

Wen, J., Khalid, S., Mahmood, H., & Yang, X. (2022). Economic policy uncertainty and growth nexus in Pakistan : a new evidence using NARDL model. Economic Change and Restructuring, 55(3), 1701–1715. https://doi.org/10.1007/s10644-021-09364-2

Yu, J., Shi, X., Guo, D., & Yang, L. (2021). Economic policy uncertainty (EPU) and firms' carbon emissions: Evidence using a China provincial EPU index. Energy Economics, 105071. https://doi.org/10.1016/j.eneco.2020.105071

Zakari, A., Adedoyin, F. F., & Bekun, F. V. (2021). The effect of energy consumption on the environment in the OECD countries : economic policy uncertainty perspectives. 52295–52305.

Zameer, H., Yasmeen, H., Zafar, M. W., Waheed, A., & Sinha, A. (2020). Analyzing the association between innovation , economic growth , and environment : divulging the importance of FDI and trade openness in India. 29539–29553.

Zhi-Guo, L., Cheng, H., & Dong-Ming, W. (2018). Empirical research on the relationship between natural gas consumption and economic growth in the Northeast Asia. Energy and Environment, 29(2), 216–231. https://doi.org/10.1177/0958305X17745273