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Article

Impact of Energy Crises on Income Inequality: An Application of Piketty's Hypothesis to Pakistan

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Abstract: In Pakistan, the majority of people have access to energy supplies. However, people who are underprivileged, below the extreme poverty line, or part of the middle class often spend disproportionate portions of their income on energy supplies and services, to some extent because of higher upfront prices for energy supplies, expensive products, and expensive imported appliances. The nonavailability of low-cost energy supplies is mainly affecting underdeveloped regions that have mostly low-income households. We used the dynamic ordinary least squares method to look at the impact of the energy crisis on income inequality from 1997 to 2021. The results show that the energy crisis exacerbates income inequality as low-income groups end up spending more significant shares of their income on energy products, supplies, and services than higher-income groups. Fair and equal access to energy supplies and services is less likely to reduce income inequality if prices are not cost-efficient. Cautious deliberation regarding the structure of energy tariffs is inevitable; at the same time, safety nets and social security programs for the poorest groups need to be expanded. At this stage, the aim is to target energy prices that will achieve the objectives of reducing polarity and increasing real income.

Keywords: energy crisis; income inequality; Piketty's hypothesis



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1. Introduction

The distribution of resources has always been one of the central points of socioeconomic and sociopolitical policy-making history, as well as the history of class struggle, a struggle for resource acquisition and exploitation (Marx and Engels 2008). This article delves into this critical yet overlooked area in the context of Pakistan, aiming to contribute to the existing literature by examining the historical and contemporary aspects of resource distribution. Here, we define the term 'energy crisis', central to our discussion, as the significant lack of energy supplies and accessibility, particularly affecting the lower and middle classes and exacerbating income inequality. The impact of the Industrial Policy (1948) and the Green Revolution (1959), though responsible for modest economic growth from 1948 to 1966, laid the foundations for the vast disparity in society with the emergence of industrial capitalist, feudal, and agricultural capitalist classes. The period from 1979 to 1989 marked an adjustment toward free enterprise development and transformation; as a result, the capitalists flourished. The decade of 1990–2000 in the history of the country and the accompanying political volatility did not add much to the redistribution of resources

or to lifting the lower and middle classes. This ongoing issue of resource distribution and its historical roots needs in-depth investigation. Moreover, the political stability crisis was vital in contributing to income inequality, as well as the energy crisis, during this period. The political climate was not stabilized through any remarkable or notable institutional capacity-building programs in the years 2000 to 2007; rather, ad hoc adjustment policies continued to be enforced as a popular method of running state affairs. The energy fabric and system collapsed during the recession, led by the energy crisis in 2007, and there was not much that political and economic institutions could offer to society (Zaidi 2015).

The country is still struggling with the aftermath of the policy-incapacitated outcomes of the past. As a result, inequality kept gradually increasing; the share of total income of the poorest 20 percent decreased during the period from 1997 to 2021, while the share of the wealthiest 20 percent increased. The share of the poorest 20 percent increased slightly during the 1980s. However, their share started to decline again in the 1990s and reached 6.37 percent by 2004. On the other hand, the share of the wealthiest 20 percent increased during the period from 1997 to 2021 and reached 50.02 percent in the period from 2009 to 2010 (World Bank Group 2014). Although the average income level in Pakistan is slightly increasing, along with economic growth of almost 5 percent, the gap between socioeconomic classes has not improved significantly. In this context, this article examines the factors beyond income levels that shape equality in society, with a special focus on the availability and affordability of energy resources. This article shows that there are factors other than income levels and economic growth that have significant roles in shaping equality in society. Two of these critical factors are affordable energy services and access to energy resources. The growing and creeping crisis in the energy sector over the years, as a result of persistent political uncertainty in the country, has been decreasing the capacity of the masses to access energy resources; for Murtaza and Faridi (2015), it has increased energy poverty, which reflects the persistency of the lack of energy supplies and the inability of the masses to access resources. At the same time, the limited availability of energy supplies and services has been reducing the real income of the masses over the years.

According to Cheema and Sial (2012), this increasing income inequality despite increasing economic growth rates is due to the unfair distribution of resources among provinces and the biased distribution between rural and urban areas. In the case of rural–urban polarization, a similar conclusion was reached by Awan et al. (2013), in that the ability to access energy services in rural areas is relatively lower than in urban areas. Moreover, Haq and Shirazi (1998) concluded that, in terms of nonfood expenditure, economic welfare levels in rural areas are comparable to those of the urban sector, and they proposed that policies should be directed toward enhancing the expenditure capacity of the poorest groups. Nwosu et al. (2018) showed that nonfood expenditure is a major source of inequality in household consumption expenditures in both urban and rural areas and that variables such as living in rural areas, household size, type of household dwelling, and household dwelling characteristics account for significant proportions of inequality in food and nonfood expenditures. Murtaza and Faridi (2015) blamed income polarization for expanding income poverty and energy poverty, which reflects the decreasing consumption expenditures.

Pakistan is among the weakest countries in the world in terms of the Sustainable Energy Development Index (SEDI), the Human Development Index (HDI), and the Energy Poverty Index (EPI) tested globally. This implies that the average household in Pakistan has to spend a large portion of its income to acquire energy supplies and services every time there is an energy crisis or oil prices increase. As over-dependency on external energy supplies shifts wealth from the local economy to the foreign, leaving less for the locals, the growth in household final consumption expenditure has decreased over the years in the country (Iddrisu and Bhattacharyya 2015). Kuznets (1955) contributed to the issue of income and resource distribution by empirically analyzing income inequality. He believed that countries face serious inequality issues when the economy is in the ‘take-off’ stage

and moving toward industrialization; however, the issue of inequality stabilizes after the achievement of the steady-state level.

Piketty (2014), on the other hand, dived into the wealth and tax data for France, Germany, Japan, the United Kingdom, and the USA, from 1810 to 2010, to study the resource distributions and income inequalities in these countries. He believes that the concept of inequality in the field of economics is insufficient, especially while using the relationship between the economic growth rate and income shares. He expands his detailed discussion and proposes that, if the rate of return from capital (r) exceeds the growth rate of the economy (g) over a steady period, it gives rise to the problem of income inequality (Piketty 2015). Despite expanding the critique on his theory of income inequality, he proposes that, in addition to the $r > g$ hypothesis for explaining income inequality, institutional changes and political shocks remain as integral and indigenous parts of this income inequality function (Piketty 2015). The extension of Piketty's hypothesis presents a valid fit in the case of Pakistan, where political instability over the years has been responsible for this reduction in institutional capacities; as a result, despite increasing growth rates and income levels, income inequality is on the rise, especially after the 1990s. Lakner (2016) noted that the crucial aspects of measure Piketty's (2014) that make it more relevant and appropriate are as follows: First, it does not underestimate the incomes and expenditures of wealthy households, as Atkinson et al. (2011) feared that most of the household surveys do a poor job capturing the incomes and consumptions of the richest. Second, it captures the capital incomes and profits of the entrepreneurial process, which household surveys in developing countries fail to incorporate (Alvaredo and Gasparini 2015). Third, consumption surveys, in use primarily in underdeveloped and developing countries, tend to undermine the actual picture of the living standards of the wealthy class, who tend to save more than the bottom fractions of a society (Aguilar and Bils 2015). Only 40 percent of the total population of Pakistan has access to clean fuel and technologies for cooking, and this is biased toward urban areas, where almost 98 percent of consumers have access to electricity, whereas only 90 percent of consumers in rural areas have the same access (World Bank 2018). The access, availability, and affordability of energy supplies, services, and technologies have wide disparities between the urban and rural, rich and poor, and haves and have-nots in Pakistan. This increasing inequality in energy resource distribution, energy supply disparities (Mahmood and Shah 2017), and income and energy poverty (Murtaza and Faridi 2015) in the presence of a persistent, unstable political system is causing increasing income inequality in Pakistan (Shehzadi et al. 2019).

The existing literature provides a foundation for understanding the relationship between energy access and income inequality. Studies have shown that unequal access to energy can exacerbate income disparities (Bazilian and Yumkella 2015; Bouzarovski and Herrero 2017). In Pakistan, energy poverty has been identified as a significant issue affecting low-income households (Mahmood and Shah 2017). This study builds on these findings by applying Piketty's hypothesis of resource distribution to the context of Pakistan's energy crisis.

The Kuznets curve has been a popular benchmark for understanding the relationship between economic growth and income inequality. This popularity was particularly notable during the mid-20th century.

Acemoglu and Robinson (2013) provide a deeper insight into situations in which there is an abundance of energy but high inequality. Their work suggests that inclusive political institutions are necessary to ensure equitable resource distribution.

Atkinson's contributions, particularly his previous research, have similar conclusions about the relationship between inequality and resource distribution. This highlights the need for equitable energy policies.

Piketty's explanation of the correlations between resource distribution, growth, and income inequality suggests that unequal resource distribution leads to increased inequality. Resource distribution, in this context, includes access to energy, which is essential for economic growth and reducing inequality. Grunewald et al. (2014) imply that a reduction

in CO₂ emissions, energy usage, or energy supply increases the difference between energy supply and demand, causing energy crises. [Shahbaz \(2010\)](#) tested Kuznets' theory in the context of energy and income inequality in Pakistan. The measure of income inequality used in these studies differs from Piketty's r-g model. (See Figure 1)

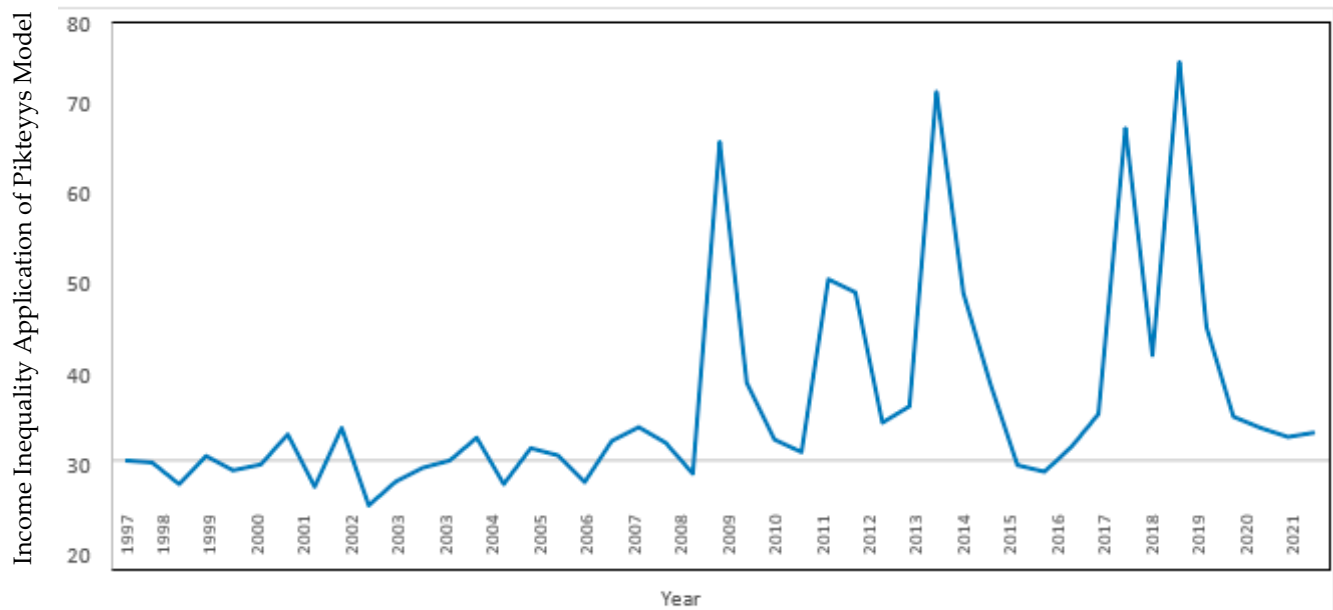


Figure 1. Application of Piketty's hypothesis on income inequality, 1997–2021.

A comparison of rural and urban areas shows that 93 percent of the urban population compared to 63 percent of the rural population in Pakistan have access to electricity ([Mahmood and Shah 2017](#)). The misery of the energy disparity and deprivation reached an alarming situation, with 19 percent of the urban and 71 percent of the rural populations not being able to afford energy services or supplies. Despite increasing average income levels in Pakistan, along with an average economic growth rate of almost five percent, household consumption expenditure is decreasing and income inequality is barely improving ([Awan et al. 2013](#)). It is evident, from the fact that, despite an increasing per capita income, the Gini coefficient increased from 30 in 1997 to 37 in 2021, and household consumption expenditure is showing a decreasing trend ([World Bank 2022](#)). The impact of the energy crisis on the rural poor is significantly more severe than that on the urban masses, and the underprivileged and the poor are spending a more significant share of their incomes on energy supplies. The energy crisis is contributing to aggravated income inequality by widening the gap between the haves and the have-nots in the country, and hampering the ability of masses to have access to energy services and supplies, by reducing the real income of the lower classes, and thus their capacity to live.

This paper makes a significant contribution by linking historical and contemporary issues of resource distribution in Pakistan with income inequality, particularly through the lens of the energy crisis. By examining the impact of policies like the Industrial Policy (1948) and the Green Revolution (1959), and their role in fostering socioeconomic disparities, the paper highlights how historical decisions have perpetuated income inequality and energy poverty. It builds on the existing literature by applying Piketty's hypothesis on resource distribution and income inequality to Pakistan's context, demonstrating that despite economic growth, the unequal distribution of energy resources exacerbates socioeconomic divides. This study underscores that beyond income levels and economic growth, access to affordable energy services is crucial in shaping societal equality. By integrating various theoretical perspectives, including Kuznets' curve and Piketty's r-g model, with empirical data on energy access and income inequality, the paper offers a nuanced analysis of how

persistent energy crises and political instability contribute to worsening income inequality in Pakistan.

The rest of this paper is as follows: Section 2 contains the literature review; Section 3 covers methodology; and Section 4 covers data analysis followed by conclusions and recommendations for future directions.

2. Literature Review

Income inequality is one of the most debated topics in the literature on socioeconomic welfare. The theory of income inequality reflects the fundamental issues of resource distribution and share, and the access of different fractions of society to national and collective resources. In every era, prominent researchers have presented their theories on income inequality, such as [Smith \(1776\)](#) who provided an essential and significant foundational understanding of income inequality through the concept of resource distribution between the laborers, the capitalists, and the landowners. He theorized that the landowner becomes richer with the growth of free markets and society as a consequence of the laborers hard work, this is the foundation of inequality in terms of resource distribution and the exploitation of the laboring class. The foundational work of Smith paved the way for Marx (1818–1883) to propose his famous theory of socioeconomic inequalities. He stated that the capitalist exploitation of resources is responsible for polarizing society and motivates the masses toward revolution as a form of class struggle. His thesis promised equality and justice in society and cured the issue of inequality with the prevalence of a dominant socialist society. On the contrary, [Skocpol \(1977\)](#) believed in the fundamental forces of market stabilization as a solution to the polarities in resource distribution and prevailing income inequalities. Wherein, [Polinsky \(1974\)](#) also conceded the possibility of fair distribution of resources through a theory of equity in factors of production. On the other hand, [Keynes \(1973\)](#) portrayed a pessimistic view of the consequences of income inequality and cautioned about the more significant damage that inequality could bring to society and the economy. Energy supply is a crucial factor for social development and growth, as well as advancements and transformations toward modernization. Limiting the supply of energy would create a crisis in societies. The sustainable flow of energy and energy use is fundamental for industrial economies and social organizations. Therefore, energy deprivation is a ‘threat multiplier’ and ‘threat instigator’ in military parlance; yet, unfortunately, it took several years for the international community and organizations to acknowledge the importance of energy sustainability and security. This energy deprivation is considered to be a clear catalyst for unrest, instability, youth unemployment, and urbanization in societies.

Income inequality is an essential determinant of socioeconomic welfare, a vital theoretical affair for policymakers and economists. It reaches resource economics with the hope of determining the redistribution of scarce resources in a way that could reduce inequalities in society. The theory of inequality by [Kuznet \(1955\)](#) remains a popular benchmark to measure the level of welfare through income distribution among different income fractions in society. Notwithstanding the popularity of Kuznets’s thesis, the application of his measure of income inequality to developing countries raises valid and contradicting questions; most such objections are debatable, yet much is left unexplained by his theory, such as cases in which urbanization, industrialization, increasing improvements in energy resources and economic growth occur side by side along with increasing income inequality, such as in Russia ([Lyubimov 2017](#)). Similarly, [Acemoglu and Robinson \(2013\)](#) explained the resource richness (energy) of countries (such as Nigeria and Middle Eastern countries) experiencing increasing inequalities, thus showing that resource distribution is not justified or rational. The problem of income inequality was addressed in the groundbreaking work of [Atkinson et al. \(2011\)](#). He proposed a solution to the measurement of income inequality and the distribution of income, consumption, and wealth in terms of subjective social function. He measured income inequality within income distribution through ‘social loss’, which can be reflected through income, consumption, or wealth. Therefore, the debate

generated about socioeconomic welfare discussed earlier in this section is justified herein to explain the concept and measurement of income inequality. He believed that, as a traditional measure of income inequality, the Gini coefficient fails to explain the welfare aspects imbedded within income inequality, such as the social loss in unjust resource distribution and income inequalities. Therefore, the Gini coefficient cannot be trusted as an ultimate, complete, and reliable measure of income inequality. The concept of social loss first originated in the work of Dalton (1920), who defined income inequality as a loss of socioeconomic welfare as a result of the unjust and uneven distribution of resources and incomes within a society.

Sen (1992) re-examined the concept and measurement of income inequality on the paradigm of capability functions such as elementary function (health, nourishment, and shelter) and social function (self-respect and community life). The realization of these sets of capabilities, as preferred by any individual, reflects his/her capability and standing in society. Therefore, the failure to provide access to and the availability of these functions for a different fraction of society reflects the prevailing level of income inequality, which hinders human freedom to enjoy the basic needs and wants. Hence, his theory explained inequality in terms of social welfare, where people compromise their ability to retain a respectable justified level of life due to nonavailability, a lack of access to collective resources, and a lack of capability. This theory enhances the concepts of social loss and socioeconomic welfare while expanding the definition and scope of the concept of income inequality. However, the promising contemporary theory of inequality from Piketty (2014, 2015) proposed a whole new dimension of income inequality and filled gaps left by earlier theories, especially in the context of macroeconomic dynamics. The proposed theoretical basis is that, when the rate of return on capital (r) is higher than the economic growth rate (g) over a reasonable period, it leads toward inequality in the society ($r > g = IE$). The theoretical architecture of this theory is based on the primary and fundamental laws of capitalism. For example, the first law says that the product of the capital–income ratio (β) and return on capital (r) are equal to the share of capital in the national income (α). The second law of capitalism asserts that β is the outcome of the ratio between national saving (s) and economic growth (g). Hence, the rate of return on capital is equal to the product share of capital within the national income and ratio between economic growth and the national savings ($r = \alpha * g/s$).

Piketty's successful explanation of the correlations between resource distribution, growth, and income inequality over a greater extent of time gives a new dimension to the field. The major concern of the theory is that rising inequalities lead the wealthy class to influence the political and economic institutions in their favor; this aspect of the theory has already gained theoretical endorsement by Acemoglu and Robinson (2013) in that extractive economic institutions favor the elite to obtain personal benefits from the state and weaken the institutions' and nations' failures despite having abundant resources. Galvin (2019) proposed that countries with weak institutions cannot prevent the impact of external shocks, such as energy shocks, and such economies are prone to experiencing an economic collapse. Hence, unjust resource distribution (energy) leads to income inequality. The theoretical base between energy used/energy supply and income inequality is not widely explored or researched. However, some researchers have used carbon dioxide (CO₂) emissions as a proxy for energy supply and developed a theoretical relationship with income inequality to lay down foundations for their theories, such as the 'equality hypothesis', which states that income inequality could be positively associated with CO₂ emissions, implying that energy-use enhancement hints toward the inequality of energy supplies and, therefore, income inequality (Boyce 1994). On the contrary, some theorists believed that increasing CO₂ emissions play a fair role in bringing inequality downward, and are thus negatively associated with income inequality (Heerink et al. 2001).

Similarly, the comprehensive theoretical justification for the relationship between CO₂ emissions/energy usage and inequality proposed by Grunewald et al. (2014), that, in the case of developing and underdeveloped countries, CO₂ emissions are negatively associated with income inequality, thus implies that more energy being used in developing countries

would decrease income inequality, as the amount of energy used is an indicator of economic growth and development. Hence, an increase in energy supplies improves economic growth, which therein extends to decreasing inequalities. The authors included Pakistan in their analysis, which, therefore, implies that a reduction in CO₂/energy usage/energy supply increases the difference between energy supply and demand, which causes energy crises. This crisis puts downward pressure on economic growth, and the decreasing economic growth deteriorates the resource distribution and income inequality in Pakistan. This theory, therefore, provided the foundations for exploring the role of an energy crisis in explaining the variations in income inequality in the case of Pakistan. On the other hand, [Khan and Heinecker \(2018\)](#) laid the foundations for a theoretical relationship between income inequality and energy supply, while reinvigorating the debate on energy efficiency and income disparity. Their proposed theory states that an increase in energy use is associated with increasing disparity and is the result of an increase in the energy cost of having 'good regulation' of the system. As the system becomes unequal, the supply of energy resources and services becomes increasingly biased toward the high-income fractions of society, where the top 20 percent of the wealthiest fraction have more access to and use of energy than the rest. The links between energy and reducing inequalities may be seen most clearly in the context of access to energy, but there are also cases of energy poverty related to fuel poverty. In situations in which people have access to energy, it is often the poorest that end up using disproportionate shares of their income to pay for energy, in part because the higher upfront costs of investments in energy services are more difficult to bear for low-income households ([Simcock et al. 2017](#)). This thus validates the claim of [Piketty \(2015\)](#) that when resource distribution favors the capitalists more than the majority, the return on capital increases more than growth, hence, creating income inequality.

Energy supply is a crucial factor in social development and growth and the advancement of the transformation of society toward modernization. A limit on the supplies of energy would create a crisis in societies. The sustainable flow of energy and energy use is fundamental for industrial economies and social organizations. Therefore, to avoid the energy crisis, industrial societies are requisite to find alternative means of energy, [York et al. \(2004\)](#). Access to energy resources and supplies is a prerequisite for development, such that the distribution of energy supplies and its access may have social repercussions and cause economic inequalities. [Awan et al. \(2013\)](#) argued that the majority of households rely on fuel consumption and noted that they face almost a 55 percent deprivation in terms of energy access, especially rural households. While reporting the bearing of the energy crisis by society, [Arslan et al. \(2014\)](#) noted that, with just the nonavailability of CNG fuel, the social and economic wellbeing of people in Pakistan is affected adversely. Moreover, they showed that the energy crisis is responsible for affecting the lifestyles of people in general. Similarly, [Simcock et al. \(2017\)](#) reported that the energy crisis has adversely affected all spheres of the wellbeing of people and has escalated the cost of living, especially for the low-income groups.

Equality and welfare both rely on a sustained and stable energy supply to all. Economic growth and development is a step toward eradication of energy deprivation and inequality, and without sustainable energy supplies, it is difficult to reach the targets of economic development. The gap between the haves and have-nots in terms of access to modern energy services is widening day by day ([World Bank 2013](#)). Economic development has proven to be a significant necessary condition to enhance the energy use of the masses; thus, it is a necessary condition to reduce an energy crisis experienced by any society, [York et al. \(2004\)](#). Moreover, energy is the most crucial and integral part of production processes and services that enable societies to move forward on the path of growth, toward development and prosperity. Access to energy resources is a serious global issue. Today more than half of the world's population is deprived of access to energy, energy-related services, appliances, and facilities. This deprivation is a significant hurdle and creates restraints for creating jobs, business opportunities, access to health, and education ([World Bank 2013](#)). However, the situations and scenarios in developing and underdeveloped coun-

tries such as Pakistan are getting worse. Moreover, countries with humongous populations and population growth rates face energy shortages. Some of the features of developing and overpopulated countries are increasing population and urbanization. Alongside other benefits, access to energy services and supplies is better, which attracts the rural population to migrate. In his cross-country study, [Liddle \(2013\)](#) found that urbanization increases with energy use.

Today more than one billion people around the world have no access to electricity. This situation is forecasted to be worse by 2030, when this number will increase by as much as two-fold. The conditions in underdeveloped and developing countries are particularly terrible ([Toman and Jemelkova 2003](#)). Moreover, rural electrification has been proven to reduce energy poverty, which consequently improves energy equity and, thus, reduces inequality. Furthermore, the amount required to mitigate the gap between the haves and have-nots in terms of access to energy services, as well as to provide the deprived masses around the world with necessary energy supplies and services, is almost USD 40 billion annually, which will rise continually until 2030 worldwide ([Schroeter 2013](#)). [Pao et al. \(2014\)](#) stressed that global initiatives are inevitable for the provision of necessary energy supplies and services to produce opportunities for growth and prosperity for underprivileged and deprived people. Unfortunately, the masses with the least access to resources cannot lift themselves out of the abyss of misery, poverty, and income inequality without access to modern energy supplies and services. The reliance on expensive oil and fuel is not going to cater to this severe issue affecting the poor of the world. Even though the solution to this crisis of income inequality and uneven access to energy resources has been proven to lead to massive progress and development in renewable energy technologies and services, the adaptation of such technologies to developing and underdeveloped nations is near nonexistent, which is a sustained threat of increasing income inequality.

The bulk of energy sources being used around the globe are not sustainable ([International Atomic Energy Agency 2005](#)); therefore, energy deprivation is a 'threat multiplier' and 'threat instigator' in military parlance; yet unfortunately, it took several years for international communities and organizations to acknowledge the importance of energy sustainability and security. This energy deprivation is considered a clear catalyst for unrest, instability, youth unemployment, and urbanization in societies ([Bazilian and Yumkella 2015](#)). The literature on energy usage/energy supply and income inequality is scarce, primarily due to the ambiguous theoretical paradigm between the two variables ([Berthe and Elie 2015](#)), and empirical studies on the energy crisis and income inequality are almost nonexistent, around the world in general, and in Pakistan in particular. Therefore, CO₂ emissions can be considered as a proxy of energy use, owing to the fact that more than 77 percent of CO₂ emissions are from energy sources ([EIA, USA 2019](#); [Ceyhan and Saribas 2022](#)). As such, [Shahbaz \(2010\)](#), while exploring the environmental Kuznets curve and the role of energy consumption in Pakistan, stated that energy consumption increases CO₂ emissions. As per [Grunewald et al. \(2014\)](#), increasing CO₂ reduces inequality in developing countries. Therefore, with increasing CO₂ emissions, income inequality may reduce in Pakistan.

In purview of this, an increase in energy consumption signals an increase in energy supplies, and if access to energy services have increased, and if this expansion includes the rural and deprived areas, it certainly provides room for us to infer that an energy supply has become available to the deprived. Therefore, in order to find to a shred of justified empirical evidence and to investigate a plausible association between energy use and income inequality, in many studies CO₂ emissions can be relied upon and inferred to be the energy usage. As such, [Heerink et al. \(2001\)](#) tested the relationship between CO₂ emissions and income inequality in 65 countries and found that a negative association between income inequality and CO₂ emissions exists. These results insinuated that the increase in CO₂ emissions reduces income inequality. Similar results are also endorsed by [Ravallion et al. \(2000\)](#) in their study using data for 42 countries from 1975 to 1992, and they proved that there is a static trade-off between CO₂ emissions and income inequality. On the

contrary, a rather comprehensive and more convincing empirical study in this aspect was completed by [Grunewald et al. \(2014\)](#), from 1980 to 2008, using a sample of 90 countries to test the relationship between CO₂ emissions and income inequality. They concluded that countries with low- and middle-income statuses possess a negative relationship between CO₂ emission and income inequality, and, on the contrary, this relationship is positive in the case of developed and high-income countries. Reaffirming the above results, in their study, [Grunewald et al. \(2017\)](#) found that, for low- and middle-income economies, higher income inequality is associated with lower carbon emissions, while in upper-middle-income and high-income economies, higher income inequality increases with per capita emissions. Since Pakistan is included in the group of low-income countries by the authors, it is implied that there is a negative relationship between CO₂ emissions and income inequality.

The studies mentioned above and their results imply that income inequality decreases as CO₂ emissions increase. And the increase in CO₂ emissions is the imposition of the fact that more energy is being used at large ([EIA, USA 2019](#)). Therefore, the possibility that more people are using more energy and have greater access to energy services with the enhanced capacity to buy energy resources may indicate a reduction in income inequality. Hence, it provides an avenue of justification that energy use is a vital tool for reducing income inequality. Moreover, the reduction in CO₂ emissions signals a drop in energy use. A sustainable supply of energy resources and services is a necessary condition for the development stages of societies. However, with the increasing utilization of energy resources, and a growing population, the stock and resources of energy supplies worldwide are decreasing significantly, raising fears for greater energy deprivation and polarity among nations and risking the share of energy for future generations ([Sahir and Qureshi 2007](#)). As such, access to energy supplies and services affect the freedom of millions around the globe to access economic opportunities. One of the reasons for areas of the world having remained underdeveloped is the lack of energy supply and services to initiate economic activities ([Bazilian and Yumkella 2015](#)). Income inequality, energy poverty, and poverty move in the same direction, as changes in energy consumption's impact are a reliable indicator of prosperity. This is why the negative correlation between modern energy services and energy deprivation is well established and proven. In order to reduce income inequality and energy deprivation, access to modern energy services by the masses must be improved ([International Energy Agency 2017](#)).

[Awan et al. \(2013\)](#) investigated the situation of energy deprivation and energy poverty in Pakistan by using the Multidimensional Energy Poverty Index (MEPI). They found a high intensity of energy deprivation and poverty throughout the country. The comparative analysis and results between rural and urban populations showed that the urban population in the country enjoys greater access to energy services than the rural population. As much as 71 percent of the population in rural areas of Pakistan are deprived of energy services and supplies compared to 29 percent in urban areas. This situation is a reflection of the prevalence of disparities in this society, in which urban populations not only have greater access to energy supplies but also socioeconomic opportunities to explore and with a higher per capita income compared to the rural populace. This also suggests that the rural populace comparatively experience a higher-pressure energy crisis, first based on their limited access to energy supplies and services, and, secondly, their ability to buy more energy when it is expensive remains low due to their income. Therefore, the persistent energy crises over the years has contributed to widening these gaps in polarity and income inequality in the country.

This study employs the dynamic ordinary least squares (DOLS) method to analyze the impact of the energy crisis on income inequality from 1997 to 2021. The DOLS method is chosen for its ability to handle endogeneity and serial correlation issues, providing unbiased and efficient estimates ([Lütkepohl 2001](#)). This method is particularly relevant for our study as it allows for the incorporation of long-term equilibrium relationships among variables, which is essential for understanding the persistent effects of energy crises on income inequality.

Although, MEPI as an index for energy deprivation and poverty, it is also an excellent way to measure the income inequality derived through energy supply and services; however, the authors believe that it does not integrate all of the elements of sustainable energy. As such, advancement in the field of energy economics is required. [Mahmood and Shah \(2017\)](#) also conceived similar results, while extending the application of MEPI to the rural and urban areas of Pakistan. Their study remained focused on a comparative analysis and investigation of the differences in energy deprivation and access to energy resources and services between rural and urban areas of the country. They found that, on average, a household in Pakistan is 26.4 percent deprived of essential energy services and supplies. The alarming nature of this situation is that this deprivation is chronic and persistent, with the deprivation in rural areas being massively greater compared to the level of energy deprivation in urban areas of the country. With these results, it can be argued that the polarity and deprivation in access to primary energy supply and services are the foundational cause of persistent income inequality and the energy crisis in the country. They believe that the lack of governing wisdom and political will are responsible for bringing society to this edge. [Murtaza and Faridi \(2015\)](#) already produced similar results and showed that the progress in energy development in Pakistan increased during the first half of this century but at a plodding pace. Unfortunately, even this slow and meagre energy development and growth started decreasing after the energy shocks and crises of 2007 and 2011, resulting in increased energy poverty, income inequality, and disparities of the country. The level of income inequality is rooted in the overall economic progress and development of a country. An increasing economic performance is considered to have an impact on the level of earnings of households, which eventually transforms into households' increasing ability to access to modern services and energy resources. Such an idea is proposed by [Kuznet \(1955\)](#), who believed that structural adjustment of economic growth can reduce the deprivation and income inequalities in society, as society crosses different levels of growth and development. He further contemplated that the very early and initial stages of economic growth yield income inequality, and later, when a steady state is achieved, income inequality is potentially reduced, based on the premise of industrialization, urbanization, and the trickle-down effect of economic growth to the lowest fraction of the society. Over the years, economists all over the world have studied the application of Kuznets theory in different scenarios without considering the collected historical data or improving the empirical validity of the theory to their respective societies ([Piketty 2014](#)). [Shahbaz \(2010\)](#) witnessed a similar application of Kuznets's theory of income inequality in Pakistan and showed that economic growth leads to a reduction in inequality. However, the author failed to align his results and outcomes with the growth stages of the underpinning theory. On the contrary, [Zouhaier and Karim \(2012\)](#) found a negative effect of economic growth on inequality and proposed the need for a better methodological understanding to obtain more accurate results. [Sharafat et al. \(2014\)](#) reached similar results and found that increasing economic growth is associated with the increase in income inequality in Pakistan.

[Sen \(1992\)](#) raised a point on the moral validity of researchers' approaches toward studying inequality rather than using objective-driven research. Similar yet rigorous results are forwarded by [Checchi and García-Peñalosa \(2008\)](#). They studied 21 countries and reached the conclusion that labor market institutions are the prominent driving force in the determination of inequality; a more reliable institution would result in decreasing inequality.

Sustained and sufficient energy resource distribution is predominantly agreed to rely on the factor of socioeconomic prosperity. However, energy resource allocation, efficiency, and conservation have long been critical elements in the energy policy dialogue. They have taken on renewed importance as concerns about global climate change and energy security have intensified in a country where 51 million or more people are still without electricity, with the national electrification rate being almost 73 percent ([World Bank Group 2014](#)). Many advocates and policymakers maintain that reducing the demand for energy is essential to meeting the challenges of energy deprivation and inequalities, and analyses tend to find that reductions in demand can be cost-effective means of addressing the

concerns of a shortage in energy supplies in the country and hence can curtail the ongoing energy crisis, being known as energy conservation plans. However, there is a difference in reducing demand and curtailing it. For instance, rural areas in Pakistan barely have a 63 percent electrification rate compared to 90 percent in urban areas, showing the inequality in energy resource distribution. Therefore, any conservation program that reduces energy demand indifferently between the urban and rural masses would hamper the social and economic activities of the country and eventually increase the threat to socioeconomic growth and welfare (World Bank Group 2014). The energy resource distribution and income inequality hypothesis proved that, in the case of developing countries, an increase in energy use decreases income inequality. Therefore, any policy that reduces energy demand helps to enhance income inequality in developing countries and, thus, serves as a threat to the welfare level of the public by increasing deprivation and has a direct bearing on income inequality (Mahmood and Shah 2017).

3. Methodology, Variables, and Model

Income inequality (*IE*) is the dependent variable, energy crisis (*EC*) is an independent variable, and oil price shocks (*OPS*), gross domestic product (*GDP*), and population (*POP*) are controlled variables. Interaction terms are introduced to capture the indirect impact of other independent variables. The role of the energy crisis (*EC*) as a determinant of income inequality (*IE*) is grounded in the theoretical and empirical findings of Grunewald et al. (2017), Awan et al. (2013), and Mahmood and Shah (2017). These studies collectively establish that a scarcity of energy production is a fundamental cause of the energy crisis, which, in turn, exacerbates income inequality. The theory of inequality (Piketty 2014) is advanced to be employed for understanding inequality at the national level. This theory states that, if the returns on capital remain greater than economic growth, this could lead to *IE*. The household final consumption expenditures (*HFCE*) are negatively affected due to the increase in *EC*; as a result, households' capacity and ability to access energy supplies is reduced, causing inequalities. As such, Bazilian and Yumkella (2015) believe that a lack of access to energy increases economic deprivation and decreases business opportunities, and this deprivation translates into *IE*. Similar propagation is contemplated by Iddrisu and Bhattacharyya (2015), who theorized that energy deprivation is a vital source of *IE* in a society, if not justified based on a rational resource distribution mechanism. The following Table 1 contains the list of variables with units of measurement and sources.

Table 1. Variables' measurement and sources.

Variable	Unit of Measurement	Data Source
Energy Crisis	Kilos of Oil Equivalent	World Bank Data Bank, Pakistan Energy Year Books, Pakistan Economic Survey, Bureau of Statistics
Political Instability	Index (0–100)	International Country Risk Guide
Inflation Rate	Percentage	Pakistan Bureau of Statistics, Economic Survey of Pakistan
Population	Numbers	Pakistan Bureau of Statistics, Economic Survey of Pakistan
Income Inequality	Rate/Percentage	Pakistan Bureau of Statistics, Economic Survey of Pakistan, House Hold Integrated Economic Survey of Pakistan, Ministry of Finance
Gross Domestic Product	United State Dollars	Pakistan Bureau of Statistics, Economic Survey of Pakistan, Ministry of Finance
Household Final Consumption Expenditure	United State Dollars	Pakistan Bureau of Statistics, Economic Survey of Pakistan, House Hold Integrated Economic Survey of Pakistan, World Bank Data Bank
Oil Price Shocks	Net Oil Price Increase	World Bank Data Bank

The data utilized in this analysis present substantial benefits, such as the credibility of sources like the World Bank and Pakistan Bureau of Statistics, and the extensive inclusion of economic, social, and energy factors. This enables a thorough analysis over time with precise measurements. Nevertheless, it is important to take into account certain restrictions, as there may be discrepancies or inconsistencies between different sources of data, the Political Instability index is subjective, and there could be variations in inflation and oil price data across different regions.

3.1. Income Inequality

Income Inequality (*IE*) is a reflection of unequal resource distribution in society. That is, if the distribution of resources is biased toward one fraction of society compared to another fraction of the same society, it leads toward disparities, and the income gap between haves and have-nots, privileged and underprivileged, increases, thus resulting in *IE*. In this study, *IE* is measured using the theoretical proposition of Piketty (2014, 2015). He introduced a novel paradigm to address inequality, notwithstanding the traditional Gini coefficient, such that the return on capital is a critical factor in the determination of income distribution in society. The measure of *IE* states that, when the rate of return on capital (r) is higher than the economic growth rate (g) over a reasonable period, it leads toward *IE* in society; $r > g \rightarrow IE$. This measure of *IE* is denoted in Equation (1).

$$IE_t = r_t - g_t; \quad t = 1, 2, \dots, T \quad (1)$$

Therefore, this study developed a measure for determining *IE* based on the theories stated above, where the outcome of Equation (2) determine the situation of *IE* in society. That is, if $IE = 0$ means no or negligible income inequality and if $IE = +ve$ implies that resources are biased toward the capitalist fraction of a society, then the possibility of *IE* increases. On the other hand, if $IE = -ve$ implies that a society's share of national resources is increasing, *IE* is thus decreasing. According to Piketty (2014), the formula for calculating the rate of return from the capital is $r = \alpha \frac{g}{s}$, $\alpha = r \cdot \beta$, and $\beta = \frac{s}{g}$.

The results of the DOLS regression analysis indicate that the energy crisis had a significant positive impact on income inequality. Table 1 presents the residual ADF test results, demonstrating the stationarity of the residuals. The Wald test results, shown in Table 2, confirm the existence of a long-term relationship between energy crisis and income inequality. The F-statistic (14.80) and chi-square statistic (88.83) are both significant at the 5% level, rejecting the null hypothesis of no long-run relationship. These findings support the third objective of this study and complement Piketty's hypothesis on resource distribution and inequality.

Table 2. VAR lag length selection criteria.

Lag	LogL	LR	FPE	AIC	SC	HQ
0	−2852.15	NA	1.95×10^{49}	136.19	136.52	136.31
1	−2469.66	601.04	5.33×10^{42}	121.03	124.01	122.12
2	−2317.29	181.40 *	1.11×10^{41}	116.08 *	122.45 *	118.88 *
3	−1967.67	125.15	7.25×10^3	126.83	122.58	118.93

* Indicates lag order selected by the criterion.

α = Share of capital income in national income;

r = Rate of return from capital;

β = Capital income ratio;

s = gross national savings rate;

g = economic growth rate.

Hence, with the changing scenarios in *EC*, the *IE* situation is hypothesized to change as well. Such that an increase in *EC* would inversely affect the buying abilities of household and provide fewer possibilities to access energy supplies. Therefore, the level of *IE* would

increase. Hence, it portrays a positive association between *EC* and *IE*. Since this research studies the effects of a higher rate of return on capital than the growth rate of the economy as a cause of income inequality in the case of Pakistan, the following variables are extracted.

3.2. Dynamic Ordinary Least Square Model

The dynamic ordinary least squares (DOLS) is used herein to achieve objective three of this study. It is a dynamic method for addressing the long-run time series of macroeconomic dynamic relationships. Particularly when those variables are cointegrated, it is imperative to understand long-run cointegrating vectors, as well as the extended cointegrated system in parameterizing in the form of an error correction mechanism; redefining the approach of DOLS became inevitable for a better and more simple explanation. Therein, the complexity of macroeconomic dynamics requires a better approach than to be handled by simple regression under OLS, especially in the presence of un-denied long-run relationships between variables in a time series and measuring the cointegrating vectors, with plausible endogeneity of the regressors. The DOLS, as a convincing solution, comes forward with a single-equation approach that addresses the endogeneity of a regressor while incorporating the leads and lags of the first difference in the regressor, and moreover, it addresses the issue of serially correlated error terms (Stock and Watson 1993). Masih and Masih (1996) had an extended application of DOLS to analyze the energy market dynamics of energy prices and demand. Therefore, it validated the role of this method as a reliable technique to inquire about the relationship between energy market dynamics and household capacities, abilities, and income inequality. A simpler version of Stock and Watson's (1993) regression can be generated using Equation (2), as follows:

$$y_t = \beta_0 + \beta_1 z_{1t} + \beta_2 z_{2t} + \beta_3 x_t + \varepsilon_t \quad (2)$$

Assume that y_t and z_t contain stochastic trends but x_t and ε_t do not. Here, only β_3 is asymptotically normal, whereas our hypothesis tests are not asymptotically valid for the variables that contain a stochastic trend (ε_t). The contribution of Stock and Watson (1993) changes Equation (4) so that the β_1 and β_2 coefficients apply to nontrending variables. Hence, DOLS comes forward as a method of estimating cointegrated models. After re-specifying and adjusting for no serial correlation, Equation (4) can be written as Equation (3), as follows:

$$y_t = \beta_0 + \beta_1 z_{1t} + \beta_2 z_{2t} + \beta_3 x_t + \beta_4 \Delta z_{1t} + \beta_5 \Delta z_{2t} + \varepsilon_t \quad (3)$$

where Δ represent change, and Δz_{1t} does not contain a stochastic trend. However, the paucity of serial correlation complicates DOLS; therefore, the model is extended in Equation (4), as follows:

$$y_t = \beta_0 + \beta_1 z_{1t} + \beta_3 x_t + \varepsilon_t \quad (4)$$

where y_t and z_{1t} contains a stochastic trend. Rewriting Equation (4) to reach to Equation (5) produces the following:

$$y_t = \beta_0 + \beta_1 z_{1t} + \beta_3 x_t + \gamma_1 \Delta z_{1,t+2} + \gamma_2 \Delta z_{1,t+1} + \gamma_3 \Delta z_{1,t} + \gamma_4 \Delta z_{1,t-1} + \gamma_5 \Delta z_{1,t-2} + \varepsilon_t \quad (5)$$

Therefore, a general, composite, and single equation for Stock and Watson could be summarized in Equation (6), as follows:

$$y_t = \alpha_0 + \beta X + \sum_{j=-q}^p d \Delta \ln y_{t-j} + \varepsilon_t \quad (6)$$

where α_0 is the intercept; $t = 1, 2, \dots, n$; and $j = 1, 2, \dots, q$, β is a co-integrating vector, representing a long-run cumulative multiplier. The purpose of including lag and lead lengths is to make the stochastic error term independent of past innovations in stochastic regression.

The study also proposes an integrated model for *IE* based on the theories and discussions in the preceding sections. Based on Stock and Watson (1993), the study developed a

DOLS model for understanding the relationship between *EC* and *IE*. The primary function declares that the *IE* is a function of *EC*, along with other controlled variables, provided that all variables are $I(1)$; then, the study proceeds to implement DOLS in Equation (8). The long-run estimate of the optimal DOLS model is adjusted herein based on [Stock and Watson \(1993\)](#) and [Masih and Masih \(1996\)](#).

The links between energy access and reducing inequalities have been evident in the form of access to and the supply of energy. In Pakistan, while the majority may have access to energy supplies, underprivileged and middle-class households often spend a disproportionate portion of their incomes on energy due to higher prices. The nonavailability of low-cost energy supplies mainly affects underdeveloped regions with low-income households. Therefore, augmenting and extending supplies of modern, domestic, cleaner, indigenous, and low-cost energy is significant for this stratum of society. It is equally essential to reduce the excessive share of these groups' expenditures on energy supplies and services. Cautious deliberation regarding energy tariff structures is inevitable, and safety nets and social security programs for the poorest should be expanded. At this stage, targeting energy prices to fulfill the objectives of reducing polarities and increasing real incomes is crucial. Expanding cost-effective and efficient household devices related to housing, transportation, agriculture, small domestic scale production, and water pumping is also necessary. Energy policy initiatives should transform from a binary understanding to a qualitative paradigm regarding access, availability, provision of energy, and income inequality.

where $t = 1, 2, \dots, n$; $j = 1, 2, \dots, q$; and IE_t are dependent variables, EC_t is a matrix of the explanatory variable; and β is the co-integrating vector, which represents the long-run cumulative multiplier. The direct relationship of explanatory variables with the dependent variable is denoted by

where β_i , ($i = 1, 2, \dots, 7$) and the indirect relationships between explanatory variables are represented through interaction terms, which are denoted by d_i , ($i = 1, 2, \dots, 7$). In the end, the unit root test is performed on the residuals of the estimated DOLS regression in order to test for spurious regression. After the confirmation of the nonstationary residuals, the co-integration regression proceeds.

Diagnostic Checking

The prevailing literature on econometrics lays a strong emphasis on the procedural fairness and quality of a model's specification, such as the assumption of normality of model's error term, structural specification of the model, the choice of regressors, and measurement error. There is no doubt that diagnostic testing is now firmly established as a central topic in both econometric theory and practice ([Hendry et al. 1980](#)). DOLS by [Stock and Watson \(1993\)](#) has good robustness in the context of deviations from assumptions of standard regression, especially when it comes to residual correlation, heteroscedasticity, misspecification of functional form, and nonnormality of residuals. The stability tests were employed in the form of the CUSM and CUSMSQ so that the stability of the model could be verified and validated. Furthermore, one of the conditions for the application of DOLS is that the stationarity of the DOLS model's residual is checked in the long run and subsequently employed.

4. Results and Discussion

The results for the lag selection criteria, as shown in Table 1, are for the optimal lag for the DOLS, wherein the values of AIC, LR, FPE, and SC are all statistically significant. However, the value of AIC is 116.8, which is the lowest among all of the criteria and is significant at two lags.

The presence and significance of cointegration, which is a necessary condition for the application of DOLS, was tested and the results are displayed in Table 2.

The trace test specifies at least five cointegrating equations which have a p -value less than $\alpha = 0.05$, implying that the H_0 of no cointegration is rejected. The trace results show evidence of having superior performance in cases in which the process has two

or more cointegrating relations than the amount specified under the null hypothesis. [Lütkepohl \(2001\)](#) concluded by advising that both tests should be executed simultaneously or that the trace test should be applied exclusively. The max-eigenvalue test shows that at least five cointegrating equations have p -values less than $\alpha = 0.05$; thus, the H_0 of no cointegration is rejected. Therefore, the model satisfies the condition of the long-run relationship amongst variables. Henceforth, the proposed DOLS for dynamic long-run analysis is applied.

4.1. Long-Run Dynamic Results

The long-run DOLS estimation results are exhibited in Table 3, which shows the long-run relationship between *EC*, *PIS*, *OPS*, and other controlled variables, such as *GDP*, *INF*, and *HFCE*, and income inequality (*IE*). The model opts for one less lag than the prescribed optimal lag selection and, thus, relies on two leads. The presence of leads along with lag is to support in maintaining the asymptotic significance of the model's residual, which is a mandatory condition before the application of DOLS. Therefore, the test enables us to institute the possibility of a dynamic long-run affiliation in the model.

Table 3. Johansen's cointegration test.

No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob. **	Statistic	Critical Value	Prob. **
None *	0.93	110.17	52.36	0.00	347.73	159.52	0.00
At most 1 *	0.87	85.17	46.23	0.00	237.56	125.61	0.00
At most 2 *	0.74	56.50	40.07	0.00	152.38	95.75	0.00
At most 3 *	0.59	37.11	33.87	0.01	95.88	69.81	0.001
At most 4 *	0.52	30.54	27.58	0.02	58.77	47.85	0.003
At most 5	0.30	15.02	21.13	0.28	28.22	29.79	0.07
At most 6	0.16	7.51	14.26	0.42	13.19	15.49	0.10
At most 7 *	0.12	5.68	3.84	0.01	5.68	3.84	0.01

Trace test indicates 5 cointegrating equation(s) at the 0.05 level. Max-eigenvalue test indicates 5 cointegrating equation(s) at the 0.05 level. * Denotes rejection of the hypothesis at the 0.05 level. ** p -values.

The coefficient of *EC* is positive and statistically significant as the p -value is less than $\alpha = 0.05$. Thus, the H_0 of there being no dynamic long-run relationship between *EC* and *IE* is rejected. This implies that a one KOE increase in the *EC* deteriorates the *IE* by one percent. This means that increasing the energy supply–demand gap is creating a resource distribution disparity, such that increasing *EC* implies that less energy supplies and services are available. Therefore, its distribution becomes biased and benefits the upper and middle classes more than the lower levels of the society, thus escalating the *IE*. This outcome also suggests that the existing energy infrastructure is more urban-centric. Therefore, the effect of a crisis falls more on the rural poor, due to which the growing turmoil enhances the *IE*. This outcome also strengthens the theory of resource distribution and inequality of [Piketty \(2015\)](#) while endorsing the third research objective of this study; this result is similar to [Sharif Razavian et al. \(2014\)](#), who showed the importance of enhancing energy use in development while testing DOLS for long-run dynamic relationships. The result is also in line with the path-dependency and uneven distribution of resource (energy) theory by [Bouzarovski and Herrero \(2017\)](#), who showed energy deprivation as the incapability of a household to secure a communally and substantially required level of energy services in the home, and when this situation is widespread across the country, its spatial and social distributions are highly uneven. [Khan and Heinecker \(2018\)](#) found different levels of energy services and supplies among different fractions of European society, which is particularly similar to findings by [Mahmood and Shah \(2017\)](#) in the case of Pakistan. Hence, they established that the *IE* can be explained by the current unjustified allocation of energy resources, in the long run, reflected in the persistent *EC*. In similar terms, deprivation of required energy is considered to be a social loss by [Lutzenhiser \(1993\)](#), with prior support and approval in the form of the capabilities theory by [Sen \(1992\)](#).

The negative and significant coefficient of *PIS* implies that improvements in political structures, processes, and sustainability reduce *IE*. The outcome also supports the theories of [Lipset \(1960\)](#) and [Piketty \(2014\)](#), which is an approval of this study's hypothesis. Therefore, the *PIS* is responsible for creating the situation of resource distribution disparity in the country. Since the disparities in the country do not seem to be improving despite maintaining an economic growth rate of 4.5 percent, this indicates, according to [Easterly \(2003\)](#), a weak political structure and system. As a weak institution cannot translate policy into implantation at the ground roots of the society, a fraction of society remains excluded and deprived of the resources distributed, and the presence of weak institutions and polity means that the extractive economic agents, as per [Acemoglu and Robinson \(2013\)](#), receive the disproportionate share and benefits, and therefore inequality increases.

The negative and significant impact of *OPS* on *IE* shows that increasing shocks reduce inequality. A possible explanation can be found in [Malik et al. \(2017\)](#), who showed the significant negative long-run impact of oil price shocks on economic growth, inflation, and interest rates. Moreover, [Lakner \(2016\)](#) opined that emerging economies portray greater results in terms of *Piketty's* hypothesis because of their low capital stock and high returns on capital and income growth are concentrated at the top. Thus, with Pakistan being a developing country with healthy returns on capital and heavily dependent on energy inputs from international markets ([Malik 2012](#)), the negative and statistically significant coefficient of *OPS*, therefore, reflects that the impact of oil price shocks is due to an increase in input costs and the cost of investments ([Nazir and Hameed 2015](#)). As a result, the return on capital starts to fall. Since the monetary policy, in response to the *OPS* tends to reduce interest rates to facilitate the business and capital accumulation process, if no change in interest rates or policy rates are assumed, then an increased *OPS* would adversely affect businesses. As a result, the rate of return on capital starts decreasing, which eventually decreases the level of *IE*.

Thus, the negative sign reflects that increasing oil prices and shocks affect the capitalist class more immediately than the households, and when the return on capital falls more than the adversity of the households, the inequality in terms of *Piketty's* model starts decreasing. As noted by [Bourguignon et al. \(2015\)](#), the capital has remained the main beneficiary of the globalization of trade and the resulting acceleration in the economic progress over the last two decades. Thus, the results show that as much as a one percent increase in the net oil price, considered oil price shocks as per [Hamilton \(1983\)](#) and [Bernanke et al. \(1997\)](#), could decrease income inequality by four percent. The significant part of measuring inequality using *Piketty's* model is that it reflects the inequality that occurred in society due to the extra flourishing of capital, enterprise, and the business. It also reflects that resources are being disproportionately devoted toward enterprise growth than toward development, as the country has a very meek indigenous production capacity and has massive reliance on oil imports, which account for almost 80 percent of its oil requirements. This result implies that the general price level is heavily dependent on oil price dynamics, and any volatility in the international oil prices would immediately affect the domestic energy sector and spread to all other sectors of the economy ([Valasai et al. 2017](#)).

The coefficient of *HFCE* is positive and statistically significant at the 10 percent level, implying that increasing the *HFCE* increases the *IE*. This reflects that an increasing rate of consumption expenditures exacerbates inequality in the country. As the measure of *IE* by [Piketty \(2014\)](#) incorporates the incomes and expenditures of the capitalist and rich fraction of the society ([Lakner 2016](#)), increasing expenditures therefore reflect more income and returns on capital. Thus, the gap keeps increasing with increasing household expenditure. Inflation has a positive and significant coefficient, implying that increasing inflation deteriorates the resource distribution fairness, and the lower-income fraction is more affected. As inflation in Pakistan is directly associated with world energy prices ([Malik 2012](#)), increasing prices, therefore, decreases the purchasing power of the household and keeps them deprived of energy services and supplies ([Ali 2014](#)). Moreover, [Haider et al. \(2014\)](#) believed that the inflation rate in Pakistan is predominantly driven by international energy

market dynamics and oil price shocks. Hence, the deprived fraction of the society loses purchasing power and the ability to deal with inflation. As a result, their actual incomes decrease, while inflation does not affect the upper fraction of the society. Resultantly, the gap increases, i.e., *IE*.

Moreover, the negative statistically significant coefficient of *GDP* implies that increased growth in the economy would reduce the pressure on *IE*. Therefore, the unstable economic situation of the country is a significant contributor to creating inequalities in resource distributions (Shahbaz 2010). Out of all the factors, terrorism and the failure of the government to control the threat are the most significant factors in the declining *GDP*. These adversely volatile conditions in the country scare off local, as well as foreign, investors from any existing or future investments. The decline in productive output and ever-increasing demand has created inflation, causing unemployment and poverty to prevail throughout these years (Tabassam et al. 2016). On the other hand, the positive and significant coefficient of *POP* implies that increasing the population is responsible for creating the relative deficiency in the resource supply, which creates the problem of *IE*. Hence, it can safely be inferred that increasing population levels over the years have been significant contributors to *IE* in the country. The distribution of authority and finances divides the community into different classes and results in an unstable and less fair distribution of resources. This imbalance gives opportunities to the elite for personal benefits. The misconduct and lack of administration lead citizens experience corruption at different levels. The decision-making policies ultimately benefit decisionmakers and the elite (Khan 2015).

4.2. Diagnostic Checking

There is a fair chance in econometric modeling for misspecification in regression analysis, with plausible adverse effects on the sampling properties of both the estimators and tests. Thus, they possess equal implications when attempting inferences and forecasting for the fitted model. The prevailing literature on econometrics lays strong emphasis on procedural fairness and the quality of the model's specification, such as the assumption of normality of the model's error term, structural specification of the model, the choice of regressors, and measurement error. Undoubtedly, diagnostic testing nowadays is recognized as a crucial subject in both econometric theory and practice. Some useful general references in this field include Krämer et al. (1986), Godfrey (1988, 1996), and White (1994), among many others. One of the conditions for the application of DOLS is that it requires us to check the stationarity of the DOLS model's residual in the long run. Hence, the estimations of DOLS in Table 4 proceed to Table 5 for the unit-root testing of its residual. The results show that the DOLS residual has no unit-root issue, as the *p*-value of ADF test is zero, which is less than $\alpha = 0.05$, thus rejecting the H_0 of a unit root in the residual of DOLS model.

After the clarification of stationarity for the long-run DOLS, it is pertinent to address the presence of the long-run relationship through the Wald Test. The results are exhibited in Table 6. As *p*-values of χ^2 and *F*-statistics is 0.00 and 0.01 (See Table 7), respectively, is less than $\alpha = 0.05$. Therefore, the H_0 of a no long-run relationship is rejected. Hence, it implies the exists of a significant long-run relationship. The results thus support and affirm the third objective of this study and complement Piketty's hypothesis of resource distribution and inequality.

A schematic representation of the CUSUM is presented in Figure 2 and the CUSUMSQ in is presented Figure 3, establishing that the stability condition falls within the satisfactory section with the Akaike graph that underpinned the maximum lag selection criterion.

Table 4. Long-run dynamic estimation results.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
EC	1.00	0.22	4.36	0.01 *
PIS	−8.40	2.04	−4.11	0.01 *
OPS	−4.08	1.62	−2.52	0.06 **
INF	6.11	1.68	3.63	0.02 *
HFCE	8.80	4.05	2.17	0.09 **
GDP	-3.19×10^{-9}	6.97×10^{-10}	−4.57	0.01 *
POP	3.11×10^{-6}	1.01×10^{-6}	3.08	0.03 *
C	−1882.1	413.29	−4.55	0.01 *
R-Squared	0.96	Mean Dependent Var. S.D. Dependent Var. Sum Squared Resid.	11.41	
Adjusted R-Squared	0.68		20.45	
S.E. of Regression	11.46		525.54	
Long-Run Variance	53.26			

*, ** Denote significance at 5 percent and 10 percent, respectively.

Table 5. Null hypothesis: D (DOLSRESIDUALS) has a unit root.

	t-Statistic	Prob.
Augmented Dickey–Fuller Test Statistic	−6.26	0.00 *
Test Critical Values:		
1% level	−3.65	
5% level	−2.95	
10% level	−2.61	

* Denotes significance at the 5 percent.

Table 6. Dynamic DOLS residual ADF test.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(DOLSRESIDUALS(−1))	−8.80	1.40	−6.26	0.00 **
D(DOLSRESIDUALS(−1),2)	6.47	1.28	5.04	0.00 **
D(DOLSRESIDUALS(−2),2)	5.21	1.07	4.84	0.001 **
D(DOLSRESIDUALS(−3),2)	3.91	0.85	4.57	0.001 **
D(DOLSRESIDUALS(−4),2)	2.65	0.63	4.20	0.003 **
D(DOLSRESIDUALS(−5),2)	1.48	0.40	3.69	0.001 **
D(DOLSRESIDUALS(−6),2)	0.50	0.16	3.07	0.005 *
C	0.15	0.58	0.27	0.788
R-Squared	0.91	Mean Dependent var.		−0.37
Adjusted R-Squared	0.89	S.D. Dependent var.		10.02
S.E. of Regression	3.31	Akaike Info Criterion		5.44
Sum Squared Resid.	263.63	Schwarz Criterion		5.81
Log-Likelihood	−79.14	Hannan–Quinn Criteria		5.56
F-Statistic	37.08	Durbin–Watson Stat.		2.02
Prob. (F-Statistic)	0.000			

*, ** Denote significance at the 5 percent and 10 percent, respectively.

Table 7. Wald Test for DOLS.

Test Statistic	Value	df	Prob.
F-statistic	14.80	(6, 4)	0.01 *
χ^2	88.83	6	0.00 *
Null Hypothesis: C(2) = C(3) = C(4) = C(5) = C(6) = C(7) = 0			

* Denotes significance at 5 percent.

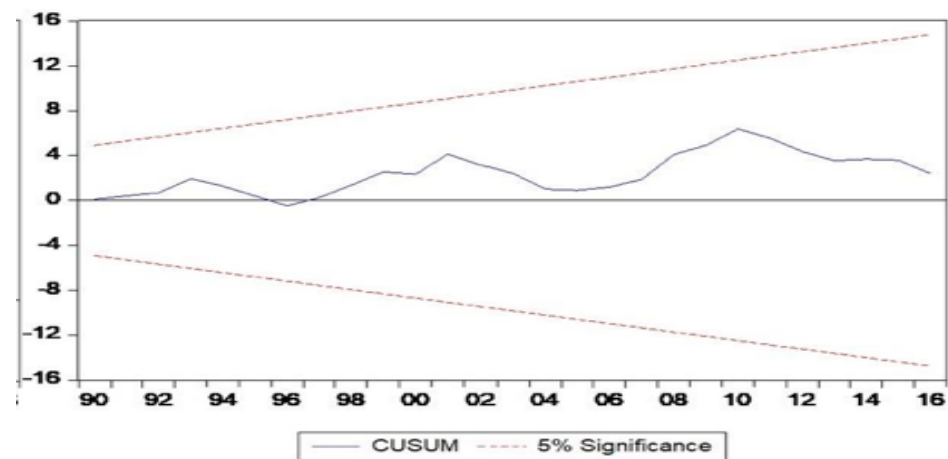


Figure 2. CUSUM.

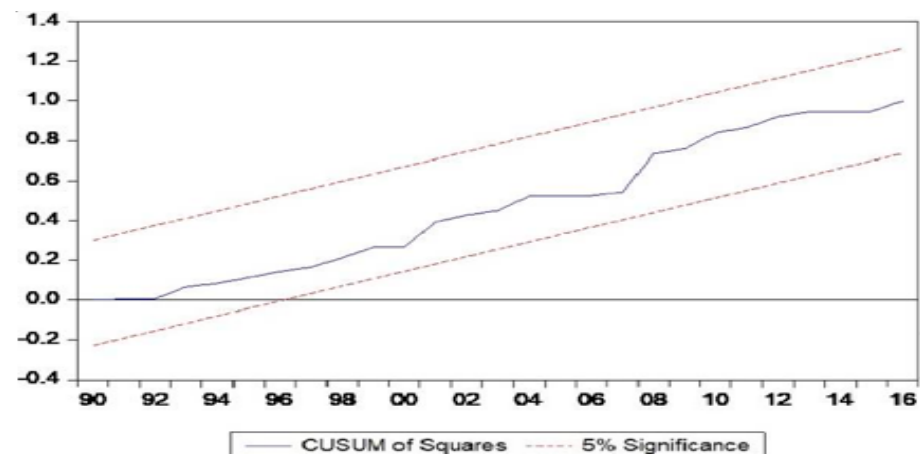


Figure 3. CUSUMSQ.

5. Conclusions and Policy Recommendations

The links between energy and reducing inequalities have been witnessed in an evident manner in the forms of the access to and the supply of energy. In Pakistan, the majority of people may have access to energy supplies. However, it is often the fractions of society that are underprivileged, below the extreme poverty line, and the middle classes who are using disproportionate amounts of their incomes to pay for energy supplies and services; to some extent, this is because of the higher upfront prices of energy supplies, expensive products, and expensive imported energy appliances. The nonavailability of low-cost energy supplies mainly affects underdeveloped regions, which have the majority of low-income households. However, this is equally applicable to middle- and lower-income groups of the country, who generally compose the majority living in underprivileged rural areas, for whom energy is an inelastic fundamental necessity of living, and a significant fraction of their energy consumption is to ensure basic survival. Therefore, augmenting and extending the supplies of modern, domestic, cleaner, indigenous, and low-cost types of energy are significant for this stratum of society. At the same time, the equally inevitable requirement is to diminish the excessive share of these groups' expenditures on energy supplies and services. The analysis of the results in the previous section shows that in most of the country, low-income groups spend a more significant share of their income on energy products, supplies, and services than higher-income fractions.

Fair and equal access to energy supplies and services is less likely to reduce income inequality if it is not cost efficient, which is an unfortunate fact in the case of Pakistan. The electricity tariff systems create nonproductive indications for the provision of low-cost

supplies of energy instead of leading and facilitating access to energy sources. Cautious deliberation regarding energy tariff structures is inevitable, but at the same time, the safety nets and social security programs for the poorest needed to be expanded. At this stage, the energy supply is targeting energy prices that will substantially fulfil the objectives of reducing polarities and increasing real incomes, whereas it is equally important to expand cost-effective and efficient household instruments related to housing, transportation, agriculture, small domestic-scale production processes, and water pumping. Initiatives on energy policy are required to transform from a binary understanding to a qualitative paradigm regarding access, availability, provision of energy, and income inequality. There is a need to quantify the actual fraction of the total population that is deprived of basic, as well as cost-effective, energy supplies and services, and, at the same time, to encompass the barriers to providing cheap energy supplies to rural areas and constraints of small- and medium-household investments, through the Scheme for Financing Renewable Projects (State Bank of Pakistan 2016), and the associated risks. Therefore, the first plan of action for the government should be to facilitate the private sector and maintain the ease of doing business by reducing security and the related investment risks so that small-household financial policy de-risking instruments may be introduced and technical services may be provided geared toward the installation of low-cost renewable energy products for the low-income households, as per the [Alternative and Renewable Energy Policy \(2019\)](#). Ideally, it should start in rural areas which have fewer opportunities to access modern energy services and supplies. The factors that influence universal access to energy services, supplies, and quality, as well as equity should be the fundamental objective of socioeconomic and sociopolitical decision-making institutions. The political elite should moderate their consensus around the provision of affordable energy supplies to reduce energy poverty, energy deprivation, and inequalities. This may require the implementation of strict transparency measures in the energy sector, harmonizing the provinces, including Gilgit-Baltistan, Azad Jammu Kashmir, private stakeholders, and provincial governments, for integrated energy policies for a grassroots-level transformation. The draft of an inclusive, unified, integrated energy policy to be enforced for private investors, public enterprises, and federal and local governments alike to expand and offer special energy services and supplies to rural areas and the underprivileged via clean and green initiatives should be developed. Meanwhile, regulators can devise a strategy to link energy tariffs and taxes to income levels and regulate the pricing accordingly.

Future research should focus on evaluating the impact of electricity pricing structures on different income groups and the effectiveness of social safety nets in reducing high electricity prices. It is also important to examine the barriers to the use of renewable energy solutions that benefit rural areas. In addition, research should examine how political ideology and understanding affect sustainable energy policy and explore how the private sector can contribute to enhancing public performance in improve energy access and affordability.

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References

- Acemoglu, Daron, and James Robinson. 2013. *Why Nations Fail: The Origins of Power, Prosperity, and Poverty*. New York: Crown Publishing Group.
- Aguiar, Mark, and Mark Bils. 2015. Has consumption inequality mirrored income inequality? *American Economic Review* 105: 2725–56. [CrossRef]
- Ali, Sharafat. 2014. Inflation, Income inequality, and economic growth in Pakistan: A cointegration analysis. *International Journal of Economic Practices and Theories* 4: 33–42.
- Alternative and Renewable Energy Policy. 2019. Available online: https://climate-laws.org/document/alternative-and-renewable-energy-policy-2019_991c (accessed on 19 June 2023).
- Alvaredo, Facundo, and Leonardo Gasparini. 2015. Recent trends in inequality and poverty in developing countries. In *Handbook of Income Distribution*. Edited by Anthony B. Atkinson and François Bourguignon. Amsterdam: Elsevier, vol. 2.
- Arslan, Muhammad, Rashid Zaman, and R. K. Malik. 2014. Impact of CNG load shedding on daily routine: A study of Pakistan. *International Letters of Social and Humanistic Sciences* 42: 110–20. [CrossRef]
- Atkinson, Anthony B., Thomas Piketty, and Emmanuel Saez. 2011. Top incomes in the long run of history. *Journal of Economic Literature* 49: 3–71. [CrossRef]
- Awan, Rehmat Ullah, Falak Sher, and Akhtar Abbas. 2013. An investigation of multidimensional energy poverty in Pakistan. *The Pakistan Development Review* 4: 65–75.
- Bazilian, M., and K. Yumkella. 2015. *Why Energy Poverty is the Real Energy Crisis*. Global Governance. Available online: <https://www.weforum.org/agenda/2015/03/why-energy-poverty-is-the-real-energy-crisis> (accessed on 19 June 2023).
- Bernanke, Ben S., Mark Gertler, Mark Watson, Christopher A. Sims, and Benjamin M. Friedman. 1997. Systematic monetary policy and the effects of oil price shocks. *Brookings Papers on Economic Activity* 1997: 91–157. [CrossRef]
- Berthe, Alexandre, and Luc Elie. 2015. Mechanisms explaining the impact of economic inequality on environmental deterioration. *Ecological Economics* 116: 191–200. [CrossRef]
- Bouzarovski, Stefan, and Sergio Tirado Herrero. 2017. The energy divide: Integrating energy transitions, regional inequalities and poverty trends in the European Union. *European Urban and Regional Studies* 24: 69–86. [CrossRef]
- Bourguignon, Thierry, Anne-Lorraine Bouquiaux-Stablo, Pascal Candolfi, Alain Mirza, Claudia Loardi, Marc-Antoine May, Rym El-Khoury, Michel Marchand, and Michel Aupart. 2015. Very long-term outcomes of the Carpentier-Edwards Perimount valve in aortic position. *The Annals of Thoracic Surgery* 99: 831–37. [CrossRef]
- Boyce, James. 1994. Inequality as a cause of environmental degradation. *Ecological Economics* 11: 169–78. [CrossRef]
- Checchi, Daniele, and Cecilia García-Peñalosa. 2008. Labour market institutions and income inequality. *Economic Policy* 23: 602–49. [CrossRef]
- Cheema, Ahmed Raza, and Maqbool H. Sial. 2012. Poverty, income inequality, and growth in Pakistan: A pooled regression analysis. *The Lahore Journal of Economics* 17: 137–57. [CrossRef]
- Ceyhan, Gaye D., and Deniz Saribas. 2022. Research trends on climate communication in the post-truth era. *Educational and Developmental Psychologist* 39: 5–16. [CrossRef]
- Dalton, Hugh. 1920. The measurement of the inequality of incomes. *The Economic Journal* 30: 348–61. [CrossRef]
- Easterly, William. 2003. The political economy of growth without development. In *In Search of Prosperity: Analytic Narratives on Economic Growth*. Princeton: Princeton University Press, pp. 439–72.
- EIA, USA. 2019. Available online: <https://www.eia.gov/energyexplained/energy-and-the-environment/where-greenhouse-gases-come-from.php> (accessed on 19 June 2023).
- Galvin, Ray, ed. 2019. *Inequality and Energy: How Extremes of Wealth and Poverty in High Income Countries Affect CO₂ Emissions and Access to Energy*. New York: Academic Press.
- Godfrey, Leslie G. 1988. *Mis-Specification Tests in Econometrics: The Lagrange Multiplier Principle and Other Approaches*. Cambridge: Cambridge University Press.
- Godfrey, Leslie G. 1996. Mis-specification tests and their uses in econometrics. *Journal of Statistical Planning and Inference* 49: 241–60. [CrossRef]
- Grunewald, Nicole, Michael Jakob, and Ioanna Mouratiadou. 2014. Decomposing inequality in CO₂ emissions: The role of primary energy carriers and economic sectors. *Ecological Economics* 100: 183–94. [CrossRef]
- Grunewald, Nicole, Stephan Klasen, Inmaculada Martínez-Zarzoso, and Chris Muris. 2017. The trade-off between income inequality and carbon dioxide emissions. *Ecological Economics* 142: 249–56. [CrossRef]
- Haider, Adnan, Qazi Masood Ahmed, and Zohaib Jawed. 2014. Determinants of energy inflation in Pakistan: An empirical analysis. *The Pakistan Development Review* 53: 491–504. [CrossRef]
- Hamilton, James D. 1983. Oil and the macroeconomy since World War II. *The Journal of Political Economy* 91: 228–48. [CrossRef]
- Haq, Rashida, and Nasim Shah Shirazi. 1998. Trends in Inequality and Welfare in Consumption Expenditure: The Case of Pakistan. *The Pakistan Development Review* 37: 765–79. [CrossRef]
- Heerink, Nico, Abay Mulatu, and Erwin Bulte. 2001. Income inequality and the environment: Aggregation bias in environmental Kuznets curves. *Ecological Economics* 38: 359–67. [CrossRef]
- Hendry, Nico, Abay Mulatu, and Erwin Bulte. 1980. Econometrics: Alchemy or science? *Economica* 47: 387–406.

- Iddrisu, Insah, and Subhes C. Bhattacharyya. 2015. Sustainable energy development index: A multi-dimensional indicator for measuring sustainable energy development. *Renewable and Sustainable Energy Reviews* 50: 513–30. [\[CrossRef\]](#)
- International Atomic Energy Agency. 2005. *Energy Indicators for Sustainable Development: Guidelines and Methodologies*. United Nations, Department of Economic and Social Affairs, International Energy Agency. Vienna: International Atomic Energy Agency.
- International Energy Agency. 2017. *Energy Access Outlook 2017*. Paris: OECD.
- Keynes, John Maynard. 1973. *The Collected Writings of John Maynard Keynes*. 7, *The General Theory*. London: Macmillan.
- Khan, Fouad, and Paul Heinecker. 2018. Inequality and energy: Revisiting the relationship between disparity of income distribution and energy use from a complex systems perspective. *Energy Research & Social Science* 42: 184–92.
- Khan, Muhammad Arshad. 2015. Modelling and forecasting the demand for natural gas in Pakistan. *Renewable and Sustainable Energy Reviews* 49: 1145–59. [\[CrossRef\]](#)
- Krämer, Walter, Harald Sonnberger, Walter Krämer, and Harald Sonnberger. 1986. Diagnostic checking in practice. *The Linear Regression Model Under Test*, 123–55.
- Kuznet, Simon. 1955. Economic growth and income inequality. *The American Economic Review* 45: 1–28.
- Kuznets, Simon. 1955. International differences in capital formation and financing. In *Capital Formation and Economic Growth*. Princeton: Princeton University Press, pp. 19–111.
- Lakner, Christoph. 2016. *Global Inequality: The Implications of Thomas Piketty's Capital in the 21st Century*. World Bank Policy Research Working Paper, (7776). Washington, DC: The World Bank.
- Liddle, Brantley. 2013. Impact of population, age structure, and urbanization on carbon emissions/energy consumption: Evidence from macro-level, cross-country analyses. *Springer Science, Business* 35: 286–304. [\[CrossRef\]](#)
- Lipset, Seymour Martin. 1960. Party systems and the representation of social groups. *European Journal of Sociology/Archives Européennes de Sociologie* 1: 50–85. [\[CrossRef\]](#)
- Lutzenhiser, Loren. 1993. Social and behavioral aspects of energy use. *Annual Review of Energy and the Environment* 18: 247–89. [\[CrossRef\]](#)
- Lütkepohl. 2001. Vector autoregressions. In *Companion to Theoretical Econometrics*, Blackwell Companions to Contemporary Economics. Oxford: Basil Blackwell, pp. 678–99.
- Lyubimov, Ivan. 2017. Income inequality revisited 60 years later: Piketty vs. Kuznets. *Russian Journal of Economics* 3: 42–53. [\[CrossRef\]](#)
- Mahmood, Rafat, and Anwar Shah. 2017. Deprivation counts: An assessment of energy poverty in Pakistan. *The Lahore Journal of Economics* 22: 109–32. [\[CrossRef\]](#)
- Malik, Afia. 2012. *Power Crisis in Pakistan: A Crisis in Governance?* No. 2012: 1. Islamabad: Pakistan Institute of Development Economics.
- Malik, Kashif, Haram Ajmal, and Muhammad Umer Zahid. 2017. Oil price shock and its impact on the macroeconomic variables of Pakistan: A structural vector autoregressive approach. *International Journal of Energy Economics and Policy* 7: 83–92.
- Marx, Karl, and Friedrich Engels. 2008. *The Communist Manifesto*, 3rd ed. New York: Pathfinder Press.
- Masih, Abul MM, and Rumi Masih. 1996. Energy consumption, real income and temporal causality: Results from a multi-country study based on cointegration and error-correction modelling techniques. *Energy Economics* 18: 315–34. [\[CrossRef\]](#)
- Murtaza, Ghulam, and Muhammad Zahir Faridi. 2015. Causality linkages among energy poverty, income inequality, income poverty and growth: A system dynamic modelling approach. *The Pakistan Development Review* 54: 407–25.
- Nazir, Sidra, and T. Hameed. 2015. Impact of oil price and shocks on economic growth of Pakistan: Multivariate analysis (sectoral oil consumption). *Business and Economics Journal* 6: 1.
- Nwosu, Emmanuel O., Obed Ojonta, and Anthony Orji. 2018. Household consumption expenditure and inequality: Evidence from Nigerian data. *International Journal of Development Issues* 17: 266–87. [\[CrossRef\]](#)
- Pao, Hsiao-Tien, Yi-Ying Li, and Hsin-Chia Fu. 2014. Clean energy, non-clean energy, and economic growth in the MIST countries. *Energy Policy* 67: 932–42. [\[CrossRef\]](#)
- Piketty, Thomas. 2014. *Capital in Twenty First Century*. London and Cambridge: The Belknap Press of Harvard University Press.
- Piketty, Thomas. 2015. Capital in the twenty-first century. *The American Economic Review* 105: 48–53. [\[CrossRef\]](#)
- Polinsky, A. Mitchell. 1974. Economic Analysis as a Potentially Defective Product: A Buyer's Guide to Posner's "Economic Analysis of Law". *Harvard Law Review* 87: 1655–81. [\[CrossRef\]](#)
- Ravallion, Martin, Mark Heil, and Jyotsna Jalan. 2000. Carbon emissions and income inequality. *Oxford Economic Papers* 52: 651–69. [\[CrossRef\]](#)
- Schroeter. 2013. *Time to Get Serious About the Energy Crisis*. Cologny: World Economic Forum, p. 2.
- Sen, Amartya. 1992. *Inequality Re-Examined*. New York: Clarendon Press, p. 155.
- Shahbaz, Muhammad. 2010. Income inequality-economic growth and non-linearity: A case of Pakistan. *International Journal of Social Economics* 37: 613–36. [\[CrossRef\]](#)
- Sahir, Mukhtar H., and Arshad H. Qureshi. 2007. Specific concerns of Pakistan in the context of energy security issues and geopolitics of the region. *Energy Policy* 35: 2031–37. [\[CrossRef\]](#)
- Shehzadi, Iram, Hafiz Muhammad Abubakar Siddique, and M. Tariq Majeed. 2019. Impact of political instability on economic growth, poverty and income inequality. *Pakistan Business Review* 20: 825–39.
- Sharafat, A. L. I., Humayun Rashid, and Muhammad Aamir Khan. 2014. The role of small and medium enterprises and poverty in Pakistan: An empirical analysis. *Theoretical and Applied Economics* 18: 593.

- Sharif Razavian, Ali, Hossein Azizpour, Josephine Sullivan, and Stefan Carlsson. 2014. CNN features off-the-shelf: An astounding baseline for recognition. Paper presented at the IEEE Conference on Computer Vision and Pattern Recognition Workshops, Columbus, OH, USA, June 23–28; pp. 806–13.
- Simcock, Neil, Harriet Thomson, Saska Petrova, and Stefan Bouzarovski. 2017. *Energy Poverty and Vulnerability: A Global Perspective*. Hague and Abingdon: Routledge.
- Skocpol, Theda. 1977. Wallerstein's world capitalist system: A theoretical and historical critique. *American Journal of Sociology* 82: 1075–90. [CrossRef]
- Smith, Adam. 1776. *An Inquiry into the Nature and Causes of the Wealth of Nations*. Glasgow Edition of the Works and Correspondence of Adam Smith. Edited by Nicole Woolsey Biggart. New York: Oxford University Press, vol. II. Available online: http://www.ibiblio.org/ml/libri/s/SmithA_WealthNations_p.pdf (accessed on 19 June 2023).
- State Bank of Pakistan. 2016. Annual Report 2016. Available online: <https://www.sbp.org.pk/reports/annual/arFY16/Anul-index-eng-16.htm> (accessed on 19 June 2023).
- Stock, James H., and Mark W. Watson. 1993. A simple estimator of cointegrating vectors in higher order integrated systems. *Econometrica: Journal of the Econometric Society* 61: 783–820. [CrossRef]
- Tabassam, Aftab Hussain, Shujahat Haider Hashmi, and Faiz Ur Rehman. 2016. Nexus between political instability and economic growth in Pakistan. *Procedia: Social and Behavioral Sciences* 230: 225–34. [CrossRef]
- Toman, Michael A., and Barbora Jemelkova. 2003. Energy and economic development: An assessment of the state of knowledge. *The Energy Journal* 24: 93–112. [CrossRef]
- Valasai, Gordhan Das, Muhammad Aslam Uqaili, HafeezUr Rahman Memon, and Saleem Raza Samoo. 2017. Overcoming electricity crisis in Pakistan: A review of sustainable electricity options. *Renewable and Sustainable Energy Reviews* 72: 734–45. [CrossRef]
- York, Richard, Eugene A. Rosa, and Thomas Dietz. 2004. The ecological footprint intensity of national economies. *Journal of Industrial Ecology* 8: 139–54. [CrossRef]
- White, Halbert. 1994. *Estimation, Inference and Specification Analysis*. Cambridge: University Press.
- World Bank. 2013. *Toward a Sustainable Energy Future for All: Directions for the World Bank Group's Energy Sector*. World Bank's Group Energy Sector. Washington, DC: World Bank. Available online: <http://documents.worldbank.org/curated/en/745601468160524040/pdf/795970SST0SecM00box377380B00PUBLIC0.pdf> (accessed on 19 June 2023).
- World Bank. 2018. Available online: <https://documents.worldbank.org/en/publication/documents-reports/documentdetail/630671538158537244/the-world-bank-annual-report-2018> (accessed on 19 June 2023).
- World Bank. 2022. Available online: <https://www.worldbank.org/content/dam/meetings/external/annualmeeting-1/AM22-WBG-Publications-Catalog.pdf> (accessed on 19 June 2023).
- World Bank Group. 2014. World Bank. Available online: <http://data.worldbank.org/indicator> (accessed on 19 June 2023).
- Zaidi, Syed. Akbar. 2015. *Issues in Pakistan's Economy*, 3rd ed. Oxford: Oxford University Press USA.
- Zouhaier, Hadhek, and Kefi Mohamed Karim. 2012. Democracy, investment and economic growth. *International Journal of Economics and Financial Issues* 2: 233–40.

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