Energy Policy 194 (2024) 114317

Contents lists available at ScienceDirect

Energy Policy

journal homepage: www.elsevier.com/locate/enpol

Does conflict aggravate energy poverty?

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ARTICLE INFO

JEL classification:
Q4
A13
D74
F51

Keywords:
Energy poverty
Internal conflict
Internally displaced persons
Conflict intensity

ABSTRACT

A country grappling with conflict faces a multitude of socioeconomic challenges. In addition to human costs, conflicts are observed to destroy a country's energy infrastructure, such as power plants, transmission lines, and fuel supply chains, inter alia. As such, conflicts reduce access to energy products as well as clean and appropriate technologies in the afflicted economy. This aggravates the competition for resources and the energy deprivation problem among the country's survivors. Against this backdrop, this study examines the relationship between energy poverty and internal conflict, as well as the impact of internally displaced persons on energy poverty. Our study uses data from the World Bank and the Peace Research Institute Oslo (PRIO) database for 94 countries from 1996 to 2021, and employs panel logistic regression and various other estimators. We find that internal conflict and internally displaced persons contribute to increased energy poverty within and between economies, which is attributed to reduced energy consumption and limited access to electricity and clean cooking. Our results are robust to endogeneity, specification, omitted variable bias, and alternative measures of conflict.

1. Introduction

A country engulfed in internal conflict faces socioeconomic challenges that are both unique and extreme. Here, an internal conflict is defined as "a conflict between the government of a state and one or more internal opposition group(s) without intervention from other states." Numerous studies have explored how this type of conflict affects economic/political outcomes—ranging from public-sector capacity and democratic governance to foreign direct investment, stock-market returns, and international trade (Verdickt, 2018; Gennaioli and Voth, 2015; Baliga et al., 2011; Rohner et al., 2013; Li, 2006; Li and Vashchilko, 2010; Kim, 2016; Aziz and Khalid, 2019).

Several studies have examined the impact of internal conflict on energy prices, energy consumption, and the environment (see, for example, Månsson, 2014; Kerber et al., 2021; Zhang et al., 2023), but its effects on energy poverty remain largely unexplored. To date, only a few studies have analyzed the relationship between internal conflict and energy poverty, either at the regional or country level (see, e.g., Shettima et al., 2023; Omar et al., 2023), and no systematic analysis at the global level has been undertaken. This paper fills that gap in the literature. As the first study to explore the relationship between internal conflict and energy poverty using a large sample of countries covering both developed and developing countries, this paper contributes to a nascent but growing body of research on the conflict-energy poverty nexus.

Conflict can increase energy poverty[1] by limiting access to reliable and affordable energy sources. While multiple factors can reduce access to power, the destruction or disruption of energy infrastructure—including power plants, transmission lines, and fuel supply chains—is often the most immediate cause. As the conflict continues, investments in energy infrastructure may be delayed, leading to a deterioration of power systems that can continue to reduce access to reliable energy over the long term.

In addition, conflict can make it difficult for households to acquire the right energy resources, such as the correct fuel type for their heating and cooking systems. In many cases, geographic and non-energy infrastructure factors can play a significant role in determining the availability of different energy resources (Bouzarovski and Herrero, 2017; Rasul, 2014), and different energy needs (like cooking and heating) often require different energy solutions. Conflict increases the likelihood

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[1] A household is classified as "energy poor" when it cannot afford to meet its basic energy needs, which include heating, lighting, and cooking (González-Eguino, 2015; Thomson et al., 2018).

https://doi.org/10.1016/j.enpol.2024.114317
Received 29 January 2024; Received in revised form 12 August 2024; Accepted 26 August 2024
Available online 2 September 2024

of a mismatch between the available energy resources and the specific needs of households, leading to energy poverty.

Conflict can also have devastating economic effects, including rising unemployment and poverty, which can make households less able to afford whatever energy services may be available. In addition to disrupting the normal functions of the private sector, conflict can divert public spending from civilian infrastructure and public services to the security sector, with negative consequences for long-term growth. The resulting decline in household income levels will tend to push more households into energy poverty.

Conflict can also cause a sharp rise in energy prices, causing households to spend a larger share of their income on energy (Boardman, 2010; Okushima, 2016). Even a household that is otherwise unaffected by the conflict can fall into energy poverty if the increase in prices strains its ability to afford sufficient energy. Moreover, these effects are not limited to combatant countries and can cause households in other countries to fall into energy poverty. Russia's ongoing invasion of Ukraine demonstrates how a conflict-induced surge in energy prices can spill over into non-combatant countries, aggravating energy poverty (United Nations, 2022).

Sub-Saharan Africa presents numerous examples of the link between conflict and energy poverty, as it is both the most conflict-affected and the most energy-poor region in the world. According to the International Energy Agency (2022), an estimated 633 million people in sub-Saharan Africa lacked electricity access in 2021, while about 792 million people lacked access to safe and clean cooking systems. These numbers increased during the COVID-19 pandemic and the subsequent energy crisis (Baniya and Giurco, 2021). The negative correlation between energy poverty and conflict is evident from Fig. 1. Countries having a high incidence of conflict over the 1996 to 2021 period also tend to have lower access to electricity (an energy poverty dimension), with sub-Saharan African countries having one of the highest incidences of

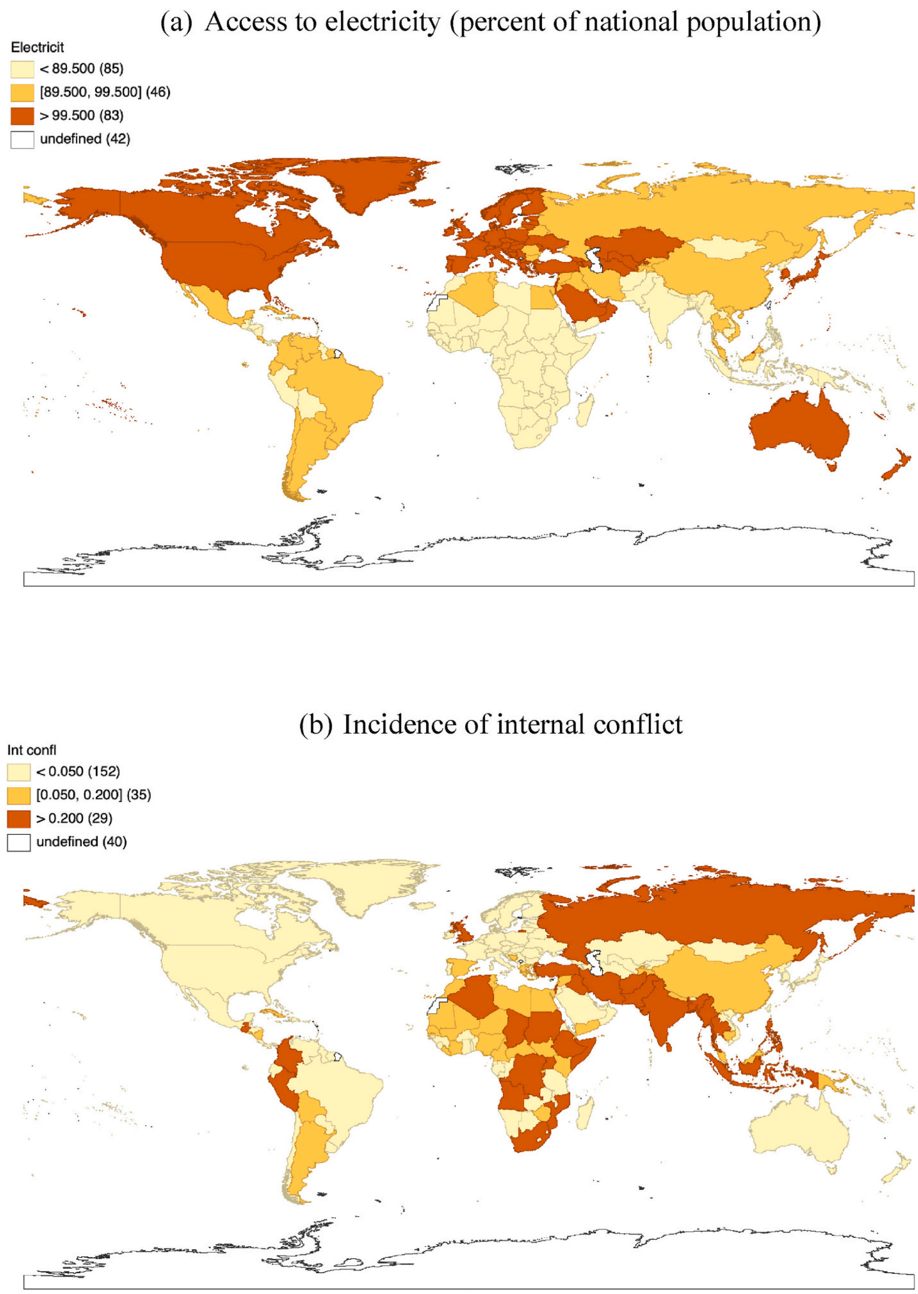


Fig. 1. Global energy poverty and conflict landscape, 1996–2021 average.
Source: World Bank (2024) and PRIO Database.

conflict and one of the lowest numbers in terms of access to electricity.

Given this backdrop, this study explores the relationship between internal conflict and energy poverty using country-level data from the World Bank and country-level indicators of internal conflict, including data on internally displaced persons from the Peace Research Institute Oslo (PRIO). Therefore, our findings are global in nature and can be generalized. We find that internal conflict and population displacement increase energy poverty within and between countries by limiting access to electricity and fuel. The estimated results are robust to different specifications, methodologies, and endogeneity concerns. We employ a number of model specifications, econometric methodologies, and variable proxies to establish the robustness of the results. Our findings have important policy implications in an era of mounting geopolitical instability, volatile energy prices, and accelerating environmental degradation.

The remainder of this paper is structured as follows: Section 2 discusses the related literature on conflict and energy poverty and describes the relationship between them. Section 3 defines the model used in the subsequent estimations and explains the data and econometric methodologies used in the study. Section 4 presents and discusses the estimated results. Section 5 concludes the paper by summarizing its findings and exploring their policy implications.

2. Literature review

2.1. Determinants of energy poverty

A sizable body of empirical literature examines the determinants of energy poverty. Some of these determinants include social well-being, health and productivity, the environment, and economic development (Reddy, 2000; Sovacool, 2012; Thomson et al., 2017b; Rodriguez-Alvarez et al., 2019; Churchill et al., 2020). Early analyses of the determinants of energy poverty found that income, as well as economic development, at both the micro- and macro-economic levels, determine energy poverty. These include Pereira et al. (2010, 2011), who observe 'rural electricity' to considerably reduce the incidence of energy poverty in Brazil. In Bangladeshi households, income is found to raise energy consumption, even though access to clean fuels and technologies remains an issue, as most households are energy-poor despite not being income-poor (Barnes et al., 2011). A qualitative analysis of Spanish household data led Phimister et al. (2015) to conclude that inadequate housing conditions (an economic outcome) result in a greater 'subjective report' of energy poverty. Okushima (2016) observes low income and high energy expenses as contributors to worsening energy poverty in Japan, especially following the Great East Japan Earthquake (GEJE).

In India, income and education are found—by Sadath and Acharya (2017) and Acharya and Sadath (2019)—to add to multidimensional energy poverty at the household level. However, additional contributing factors of energy poverty include vulnerable demographics: marginalized ('socially backward') as well as rural communities. Crentsil et al. (2019) also observe household demographic factors such as age, sex, female head, and location to determine energy poverty alongside economic factors such as level of education and wealth. Similar demographic, economic, and geographic factors are found to drive energy poverty across two developed economies (Germany and Poland)—by Drescher and Janzen (2021) and Karpinska and Śmiech (2021), respectively—as well as two developing economies (Sri Lanka and Uganda) by Jayasinghe et al. (2021) and Ssennono et al. (2021), respectively. Shafiullah et al. (2023) observe education to be a critical factor in determining household energy poverty across Chinese provinces. The authors also identify geographic disparities as well as electricity price discrimination, and fossil fuel mix as major contributing factors behind Chinese energy poverty.

Trust and ethnic diversity are noted, by Churchill and Smyth (2020), to have 'mediating roles' in determining household energy poverty in Australia—and the advanced economy. Subsequent microeconomic analyses of energy poverty in Australia reveal various other determinants, including the locus of control or belief that one's life is on track (Churchill and Smyth, 2021a), 'temperature shocks' (Churchill et al., 2022), crime in the local area (Churchill et al., 2022a), and Protestant religious beliefs (Churchill et al., 2022b). In Vietnam, Feeny et al. (2021) noted an energy poverty-aggravating impact of 'temperature shocks.' Additional demographic and economic factors behind household energy poverty include insecure employment as well as racial and ethnic disparities in South Africa and living close to 'foreign aid funded projects' in Senegal by Koomson and Churchill (2022) and Munyanyi and Churchill (2022), respectively.

The role of financial inclusion in influencing energy poverty was studied by Dogan et al. (2021) in Turkey (Türkiye) and Koomson and Danquah (2021) in Ghana. Dogan et al. (2021) argue that the channels by which financial inclusion impacts energy poverty in Turkish households include income as well as health. In contrast, Koomson and Danquah (2021) argue that the channels by which financial inclusion impacts Ghanaian household energy poverty include 'net income and consumption poverty.'

Since the late-2010s, several studies have analyzed the determinants of energy poverty at the macroeconomic level. A study of 32 European economies by Thomson et al. (2017a) revealed a greater incidence of poor health associated energy poverty. The authors also concluded that energy poverty leads to a discrepancy in health and well-being measures across Europe. Donner et al. (2022) detected the energy poverty-reducing impact of natural gas consumption across 30 Chinese provinces. Across seven South Asian economies, panel data regression analyses by Amin et al. (2020) revealed a long-run nexus (equilibrium) between energy poverty, employment, education, income per capita, inflation, and economic development. Social and demographic factors such as religiosity and culture have been found to affect energy poverty at the national level to varying extents by Ampofo and Mabefam (2021) and Chaudhry and Shafiullah (2021), respectively.

2.2. Conflict and energy poverty

There is abundant literature exploring the impact of conflict on a range of macroeconomic factors. These macroeconomic factors include measuring the economic costs of war and conflict (Abadie and Gardeazabal, 2003); exploring the relationship between war and stock returns (Verdickt, 2018); identifying the association between state capacity, democracy, and trade with conflict (Gennaioli and Voth, 2015; Baliga et al., 2011; Rohner et al., 2013); and measuring the relationship between population and conflicts (Acemoglu et al., 2020). Other researchers have explored the link between conflict and foreign direct investment (Li, 2006; Li and Vashchilko, 2010; Kim, 2016).

As is evident from the above discussion, the link between conflict and energy poverty has not been explored in the extant literature. From a theoretical standpoint, conflict can influence energy poverty through several channels. First, there is consensus in the literature that armed conflict leads to lower economic growth (Hoeffler and Reynal-Querol, 2003; Ray and Esteban, 2017). Novta and Pugacheva (2021) found that conflict has long-term consequences for economic growth and leads to a reduction in private consumption, investment, trade, and sectoral value addition. Thus, as a result of conflict, household income decreases, making it more challenging for individuals and households to afford energy services.

Second, armed conflict can also hinder and reduce the supply of energy and access to reliable energy sources. This is primarily due to the destruction of energy infrastructure, such as power plants, transmission lines, and fuel supply chains, caused by conflict (Adger, 2006; Fitzgerald, 2000; Jasiūnas et al., 2021; Lee, 2022). Consequently, energy scarcity, reduced energy availability, and difficulties in transporting and distributing fuels, such as coal, oil, and gas, can occur. Third, during times of conflict, military expenditure surges (Gupta et al., 2004), which consequently necessitates the allocation of resources between the economic interests of civilian and military sectors. Consequently, investments in energy infrastructure maintenance and development are usually put on hold, leading to deteriorating energy systems and reduced access to reliable energy sources in the long run.

Lastly, armed conflict often results in volatile energy prices at both global and local levels. A case in point is the ongoing Russia-Ukraine war, beginning in February 2022, which sent energy prices soaring and resulted in higher spending by households on meeting their energy needs (Zhang et al., 2023). A similar pattern was observed during the 1990 Iraqi invasion of Kuwait, and the subsequent Gulf War caused a spike in oil prices due to disruptions in Iraqi and Kuwaiti oil exports (Verleger, 1990). At the local level, damage to energy infrastructure, such as refineries, pipelines, and power plants, and the need to secure energy infrastructure and transport routes during times of conflict can lead to increased energy prices. These developments, in turn, limit the ability of individuals and households to source energy at cheaper prices, leading to energy poverty.

The above discussion highlights that the conflict and energy poverty nexus has been overlooked in the extant literature, and no systematic study has explored how armed (internal) conflict affects energy poverty. In addition, based on the theoretical rationales outlined in the preceding discussion, we arrive at the following hypothesis and its constituent components.

H1. *Armed (internal) conflict increases energy poverty in countries that experience conflict.*

H1a. *A larger stock of persons displaced internally due to armed conflict(s) aggravates the extent of energy poverty in affected national economies. The persistence of armed internal conflicts accumulates vast populations of internally displaced persons who compete over dwindling access to energy and appropriate services and technologies*.

H1b. *A greater intensity of armed (internal) conflict worsens energy poverty in conflict-ridden economies. When an armed (internal) conflict surpasses a certain (tolerable) threshold of intensity—say medium—there is a drastic collapse in the energy supply chain and/or infrastructure, culminating in ubiquitous deprivation of energy and relevant fuels, services, and technologies across the economy*.

3. Data and empirical strategy

3.1. Data

In order to evaluate the impact of conflict on energy poverty, we use a panel dataset of 94 countries from 1996 to 2021. The final dataset is compiled from three different sources. The energy poverty measures are calculated using data from the World Development Indicators (World Bank, 2024), while the data on conflict and other control variables are collected from the QoG dataset (Teorell et al., 2024) and the International Country Risk Guide (PRS Group, 2024) political risk dataset.

There is no consensus in the literature on the definition of energy poverty. Broadly speaking, energy poverty is a combination of energy efficiency, income, and energy prices. Energy poverty relates to the lack of affordability as well as access to energy commodities, services, and technologies. Income—be it at the micro- or macro-economic level—remains a key determinant in this regard. Income-based energy poverty measures are widespread in academic research as well as government policy (Banerjee et al., 2021; DEFRA, 2001; Churchill et al., 2020). However, all these factors boil down to the idea that energy poverty is measured as the share of income spent on energy—i.e., establishing an 'energy poverty line' (Boardman, 1991, 2010; Thomson et al., 2016, 2017b). For example, if dwellings are not energy-adequate/efficient, households are likely to spend a high percentage of their income to keep their dwellings warm—reducing affordability. Furthermore, rising energy prices also lead to spending a higher percentage of their income to meet energy expenses (Boardman, 2010; Okushima, 2016). In addition, due to associated substitution and income effects, households may be compelled to forego better energy technologies and/or services as well as reduce non-energy related expenses. On the macroeconomic front, higher energy prices may result in worsened terms of trade, culminating in reduced domestic (aggregate) consumption and investment (Katz, 2023). Bouzarovski and Petrova (2015) highlighted the importance of energy services and energy vulnerability factors, and argued that effective policies need to address issues around the geographic aspects of domestic energy deprivation.

The study employs three different proxies for measuring energy poverty, which is in line with the extant literature (Biermann, 2016; Churchill et al., 2020; Chaudhry and Shafiullah, 2021). These proxies represent the lack of affordability and access to energy as well as clean fuel technologies. They are binary (dummy) variables generated using data from World Development Indicators. The first measure (Enpov 1) is a dummy variable that takes the value 1 if energy consumption for a particular country, measured in kilograms (kg) of oil equivalent per capita, is in the bottom quartile in a particular year, and zero otherwise (see Equation (1)). This energy poverty measure is motivated, in the literature, by an absolute deprivation of energy use—under a commonly used threshold of the first quartile (Churchill and Smyth, 2021b; Hills, 2011; Chaudhry and Shafiullah, 2021; Shafiullah et al., 2023)—captures the effect of a lack of energy affordability.

$$\text{Enpov 1} = \begin{cases} 1 \text{ if Energy use} \leq 25\text{th percentile} \\ 0 \text{ otherwise} \end{cases} \tag{1}$$

The second measure of energy poverty (Enpov 2) classifies a country as energy-poor if the percentage of its population with access to clean fuels and technologies for cooking is in the bottom quartile in a particular year, and vice-versa. That is, Enpov 2 is a dummy variable that takes the value 1 if the percentage of the population of a country with access to clean fuels and technologies for cooking is in the bottom quartile in a particular year, and 0 otherwise (see Equation (2)). This energy poverty measure contrasts a country's access to clean fuels and technologies for cooking against the global average—accounting for the relative energy poverty (and vulnerability as well as inequality) of that country vis-à-vis the world. This definition remains in line with the existing literature such as Nussbaumer et al. (2012), Dugoua and Urpelainen (2014), Romero et al. (2018), Chaudhry and Shafiullah (2021), Shafiullah et al. (2023), inter alia.

$$\text{Enpov 2} = \begin{cases} 1 \text{ if Access to clean fuels and technologies for cooking} \leq 25\text{th percentile} \\ 0 \text{ otherwise} \end{cases} \tag{2}$$

The last energy poverty indicator (Enpov 3) classifies a country as energy poor if the percentage of its population with access to electricity is lower than the global median. That is, Enpov 3 is a dummy variable taking the value 1, if the percentage of a country's population with access to electricity is lower than the global median, and 0 otherwise (see Equation (3)). The argument behind Enpov 3 remains in line with the question of relative energy poverty (and vulnerability as well as inequality) due to a lack of access that is relevant to Enpov 2.

$$\text{Enpov } 3 = \begin{cases} 1 \text{ if Access to electricity} \leq 50\text{th percentile} \\ 0 \text{ otherwise} \end{cases} \quad (3)$$

The definition of the Enpov 1 measure of energy poverty supports the idea that energy-poor households spend a higher proportion of their income on energy due to high relative energy prices (Thomson et al., 2017a, 2017b; Churchill and Smyth, 2020). On the other hand, Enpov 2 and 3 measures are consistent with Sen's (1999) and Reddy's (2000) concepts of energy poverty based on a lack of access to basic energy supply and clean technologies rather than the consumption of a pre-determined energy level.

Our primary variable of interest is the internal conflict dummy that takes the value 1, if a country has experienced internal armed conflict in a given year and 0 otherwise. According to Gleditsch et al. (2002) "internal armed conflict occurs between the government of a state and one or more internal opposition group(s) without intervention from other states." The data on internal armed conflict were made available from the QoG dataset (Teorell et al., 2024), originally sourced from the UCDP Dyadic Dataset 22.1 (Pettersson, 2022; Davies et al., 2022; Gleditsch et al., 2002).

To robustly establish the link between conflict and energy poverty, we also use alternative measures that capture the presence and intensity of (internal) conflict. As an alternative measure of conflict, we use the ICRG (PRS Group, 2024) political risk dataset, which provides information on the incidence of internal conflict. The internal conflict variable varies from 0 to 12, with the lowest value indicating that the country is experiencing civil war and the highest value indicating that the government does not engage in arbitrary violence against its own citizens. These help us answer hypothesis ***H1*** and its sub-component ***H1a***.

Conflict intensity, on the other hand, is captured using two measures. The first measure is the new displacements occurring due to violence and conflict in a country within a given year. The second measure is a set of dummy variables capturing high, medium, and low intensity of conflict, created using the conflict intensity variable available from Donner et al. (2022) in the QoG dataset. The conflict intensity variable ranges from 1 to 10, with 10 indicating civil war or violent conflict along social, ethnic, or religious lines, and 1 indicating that there are no violent incidents based on social, ethnic, or religious differences. Based on this we create three dummy variables namely, Conflict intensity – high, Conflict intensity – medium, and Conflict intensity – low. Conflict intensity – high is a dummy variable that takes the value 1 if the conflict intensity is above 8, indicating the presence of civil wars and regular violent conflicts, and 0 otherwise. Conflict intensity – medium is a dummy variable that takes the value 1 if the conflict intensity is between 8 and 4, indicating the presence of mild violent incidents, and 0 otherwise. Conflict intensity – low is a dummy variable that takes the value 1 if the conflict intensity is below 4, indicating an extremely low incidence of violence, and 0 otherwise. This allows us to verify hypothesis ***H1b*** and, by extension, ***H1***.

In line with the extant literature (e.g., Chaudhry and Shafiullah, 2021), we controlled for a variety of variables that can potentially influence energy poverty in a country. These include GDP per capita, consumer price index, age dependency ratio, labor force participation rate, current account balance, manufacturing value-added, R&D expenditure, and long/short-term orientation. The motivation for including the control variables in the model is aligned with Chaudhry and Shafiullah (2021).

Table 1 presents summary statistics for the sample data. The data is divided into three sub-samples: "No internal conflict," "Internal conflict," and "Full sample." Enpov 1, Enpov 2, and Enpov 3 represent different measures of energy poverty. Among these Enpov 3 has the highest number of observations, the highest mean, and the highest standard deviation for the entire sample. For most of the control variables, the mean values for the No internal conflict sub-sample are the highest, which is intuitive as countries with no conflict are expected to perform better in terms of the consumer price index, log GDP per capita, labor force participation rate, manufacturing, R&D expenditure, and long/short-term orientation. However, the current account balance is higher in the No internal conflict sub-sample. The mean of the internal conflict dummy is 0.113, meaning, on average, there are 11.3 percent observations that represent countries with internal conflict. The number of internally displaced persons is approximately 14 million in the full sample.

Table 1
Summary statistics of the sample data used.

Variables	No internal conflict	Internal conflict	Full sample
	(1)	(2)	(3)
Enpov 1	0.051	0.280	0.076
	(0.220)	(0.451)	(0.265)
Enpov 2	0.032	0.097	0.040
	(0.177)	(0.297)	(0.196)
Enpov 3	0.151	0.508	0.191
	(0.358)	(0.501)	(0.393)
Age dependency ratio, old	19.490	11.133	18.548
	(8.517)	(4.887)	(8.604)
Consumer price index	101.518	105.570	101.974
	(41.092)	(52.724)	(42.562)
Current account balance	−0.607	−0.450	−0.589
	(7.225)	(4.485)	(6.970)
logGDP per capita	9.465	8.354	9.340
	(1.204)	(1.137)	(1.247)
Labor force participation rate	70.167	63.891	69.459
	(7.616)	(9.785)	(8.132)
Manufacturing, value added	14.748	16.716	14.970
	(5.792)	(5.790)	(5.823)
Research and development expenditure	1.206	0.960	1.179
	(1.005)	(1.168)	(1.027)
Long/short-term orientation	52.657	39.972	51.228
	(21.986)	(21.015)	(22.237)
Internal conflict dummy			0.113
			(0.316)
Internally displaced persons, new displacement-conflict and violence (number)			14439.529
			(119954.1)
Observations	1425	181	1606

Note: Parentheses provide respective standard deviations.

Table 2 provides the correlation matrix together with their statistical significance. All our explanatory variables have very low correlations with each other except log GDP per capita, which has a somewhat high correlation with the age dependency ratio and research and development expenditure. Our results are robust to these high correlations.

3.2. Model and methodology

To estimate the macroeconomic impact of conflict on energy poverty, we follow Chaudhry and Shafiullah (2021) and specify a panel model given by Equation (4).

$$\text{Energy Poverty}_{it} = \beta_0 + \beta_1 \text{Conflict}_{it} + \theta Z_{it} + \delta_t + \varepsilon_{it} \quad (4)$$

where Energy Poverty_{it} is the energy poverty indicator for country i in year t; Conflict_{it} is the conflict variable for country i in year t; Z_{it} is the vector of control variables; δ_t represents year fixed effects; and ε_{it} is the idiosyncratic error term assumed to be independently and identically distributed (i.i.d.). We estimate Equation (4) using logistic regression incorporating the time fixed effects enabling us to correctly predict the probability of being energy poor (Hoffman, 2019). A potential concern in estimating Equations (4) and (5) is the existence of endogeneity arising from the omitted variable bias. To address endogeneity concerns, we follow two approaches. First, we test for potential omitted variable bias and the coefficient stability of our conflict variable by estimating the treatment effect of conflict on energy poverty using the method proposed by Oster (2019). The Oster (2019) test assesses Equation (4)

Table 2
Correlation matrix.

	Internal conflict dummy	Internally displaced persons	Enpov 1	Enpov 2	Enpov 3	Age dependency ratio, old	Consumer price index
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Internal conflict dummy	1						
Internally displaced persons	0.150***	1					
Enpov 1	0.244***	0.140***	1				
Enpov 2	0.122***	0.0347	0.388***	1			
Enpov 3	0.300***	0.106**	0.442***	0.324***	1		
Age dependency ratio, old	−0.308***	−0.111***	−0.380***	−0.242***	−0.469***	1	
Consumer price index	−0.0905**	0.0498	−0.148***	−0.154***	−0.165***	0.168***	1
Current account balance	0.0337	−0.00106	−0.0905**	−0.0989**	−0.103**	−0.0963**	0.0545
logGDP per capita	−0.285***	−0.126***	−0.519***	−0.347***	−0.554***	0.617***	0.238***
Labor force participation rate	−0.188***	−0.124***	−0.188***	0.0176	−0.186***	0.368***	0.0997**
Manufacturing, value added	0.137***	−0.0452	−0.0141	−0.0441	0.160***	−0.0600	−0.0608
Research and development expenditure	−0.0817*	−0.0769*	−0.254***	−0.168***	−0.401***	0.514***	0.150***
Long/short-term orientation	−0.140***	−0.0531	−0.152***	−0.152***	−0.303***	0.356***	0.0188

	Current account balance	logGDP per capita	Labor force participation rate	Manufacturing, value added	Research and development expenditure	Long/short-term orientation
	(8)	(9)	(10)	(11)	(12)	(13)
Current account balance	1					
logGDP per capita	0.301***	1				
Labor force participation rate	0.0817*	0.429***	1			
Manufacturing, value added	0.112***	−0.0829*	0.0449	1		
Research and development expenditure	0.257***	0.714***	0.447***	0.128***	1	
Long/short-term orientation	0.0454	0.0719*	0.101**	0.215***	0.207***	1

Note: ***, **, & * indicate statistical significance at the 1, 5, & 10 levels of significance.

for omitted variable bias and coefficient stability of the conflict variable. As part of this procedure, model equation (4) is first estimated with one independent variable (the conflict proxy in this instance) and then estimated in full. The explanatory powers, measured by the WITHIN R^2, of the restricted and full models—($R_{Restricted}$) and (R_{Full}), respectively—are then used to compute a hypothetical 'true model' which comprises both observed and unobserved (potentially omitted) factors. The coefficient of determination or R^2 of this 'true model', the (R_{Max}), is employed in computing the 'proportionality coefficient' or δ, which gauges the relative importance of observed factors vis-à-vis their unobserved counterparts. When δ takes a magnitude greater than one (1), the model specification does not suffer from omitted variable bias(es), and the coefficient estimates of the variable in question remain valid and robust.

Second, we follow the extant literature on energy poverty and estimate Equation (4) using the Lewbel (2012) estimator and compute the Average Treatment Effect on the Treated (ATT) of internal conflict on energy poverty dimensions using Propensity Score Matching (PSM) and Entropy Balancing methods. The Lewbel (2012) approach exploits heteroskedasticity in the data to solve the issue of identification arising from endogeneity. provides methodological benefits unmatched by conventional instrumental variable regression estimators such as Two-Stage Least Squares and System Generalized Method of Moments (GMM). Lewbel's (2012) method is able to generate internal instruments by incorporating lags of both the dependent and independent variables and, consequently, does not require identifying an appropriate 'external instrument' (Chaudhry and Shafiullah, 2021). Several recent studies have analyzed energy poverty, such as Farrell and Fry (2021), Barkat et al. (2023), Chaudhry and Shafiullah (2021), Churchill and Smyth (2020, 2022), and Shafiullah et al. (2023) have employed this approach to deal with endogeneity concerns.

The ATT of internal conflict on the three energy poverty dimensions can be computed by assigning the sample data set to treatment (those afflicted with energy poverty) and control (those not afflicted with energy poverty) groups and measuring the difference in their respective outcomes. The PSM and Entropy Balancing methods can both be used to estimate the ATT, but they differ in how members are assigned to the treatment and control groups. The PSM method computes a 'propensity score' based on the control variables (of baseline model equation (4)) and assigns the units to treated and control groups by considering the 'closeness' of their propensity score values. This closeness of the propensity scores is based on a cut-off distance predetermined by the applied researcher. In this study, we use the 'nearest neighbor' approach to determine such closeness and match the control with the treated.

4. Estimated results

4.1. Baseline estimates

Table 3 shows the baseline results by estimating Equation (4) using the three measures of national-level energy poverty. The impact of internal conflict on the various proxies for energy poverty is positive and statistically significant at the one percent significance level (Panel A). The marginal effects also remain positive and significant at the one percent level (Panel B). Ceteris paribus, the presence of internal conflict within a country's borders in a particular year increases the probability of energy poverty in a country by between 1.68 and 4.3 percentage points. In particular, energy poverty due to lower energy use rises by 2.96 percentage points; lower access to clean cooking fuels and technologies rises by 1.68 percentage points; and lower access to electricity rises by 4.3 percentage points. While these magnitudes appear small, prolonged internal conflicts can result in the snowballing of such numbers.

Controlling for time (year) fixed effects, in Table 4, eventuates in a higher magnitude of the positive coefficient estimates of internal conflict on all three energy poverty measures (Panel A). The marginal effects of internal conflict, however, are now slightly larger in magnitude, ranging between 2.43 and 4.5 (Panel B). The occurrence of internal conflict in a particular year now increases energy poverty. Lower energy use rises by 3.67 percentage points; lower access to clean cooking fuels and technologies rises by 2.43 percentage points; and lower access to electricity rises by 4.5 percentage points. However, country-level fixed effects are

Table 3
Effect of internal conflict on various measures of energy poverty.

Panel A: Regression Estimates			
Explanatory variables	Dependent variable		
	Enpov 1 (1)	Enpov 2 (2)	Enpov 3 (3)
Internal conflict	0.990** (0.408)	1.855** (0.849)	0.561** (0.280)
Age dependency ratio, old	−0.417 (0.300)	−0.243 (0.709)	−0.312** (0.127)
Consumer price index	4.924 (4.084)	2.384 (6.811)	−3.076 (2.177)
Current account balance	0.670** (0.292)	0.101 (0.868)	0.00535 (0.191)
logGDP per capita	−4.638*** (0.452)	−6.951*** (0.847)	−1.786*** (0.156)
Labor force participation rate	−0.125 (0.167)	0.586** (0.282)	0.227* (0.118)
Manufacturing, value added	0.165 (0.206)	−0.354 (0.532)	0.562*** (0.148)
Research and development expenditure	−1.370* (0.759)	−4.711*** (0.989)	−0.704*** (0.207)
Long/short-term orientation	−0.681*** (0.193)	−2.298*** (0.419)	−0.878*** (0.120)
Constant	−4.947*** (0.706)	−11.95*** (1.497)	−1.251*** (0.205)
Observations	1146	1431	1606
Number of countries	90	93	94
Panel B: Marginal Effect of Internal Conflict			
Internal conflict	0.0296** (0.0119)	0.0168* (0.0087)	0.043** (0.0214)

Notes: Panel A: Robust standard errors in parentheses; Panel B: Delta-method standard errors in parentheses.
***, **, & * indicate statistical significance at the 1, 5, & 10 levels of significance. Standardized values of the control variables are used.

Table 4
Effect of internal conflict on various measures of energy poverty controlling for time FE.

Panel A: Regression Estimates			
Explanatory variables	Dependent variable		
	Enpov 1 (1)	Enpov 2 (2)	Enpov 3 (3)
Internal conflict	1.364*** (0.444)	2.762** (1.199)	0.610** (0.300)
Age dependency ratio, old	−0.765* (0.413)	−0.592 (0.837)	−0.260* (0.137)
Consumer price index	31.30*** (7.424)	−8.586 (22.71)	2.986 (1.818)
Current account balance	0.459 (0.376)	−0.115 (0.976)	0.0401 (0.188)
logGDP per capita	−5.303*** (0.620)	−8.821*** (1.603)	−1.865*** (0.171)
Labor force participation rate	−0.380** (0.178)	0.750* (0.398)	0.291** (0.129)
Manufacturing, value added	0.0805 (0.235)	0.107 (0.628)	0.559*** (0.156)
Research and development expenditure	−2.107** (0.894)	−8.201*** (1.852)	−0.775*** (0.210)
Long/short-term orientation	−0.524** (0.222)	−2.987*** (0.563)	−0.974*** (0.121)
Constant	−3.967*** (1.480)	−16.80*** (3.158)	−1.321** (0.570)
Observations	1103	1036	1391
Number of countries	90	93	94
Time Fixed Effects	Yes	Yes	Yes
Panel B: Marginal Effect of Internal Conflict			
Internal conflict	0.0367*** (0.011)	0.0243** (0.011)	0.045** (0.024)

Notes: Panel A: Robust standard errors in parentheses; Panel B: Delta-method standard errors in parentheses.
***, **, & * indicate statistical significance at the 1, 5, & 10 levels of significance. Standardized values of the control variables are used.

not found to be significant in both Tables 3 and 4

We account for the size (stock) effect of internally displaced persons on energy poverty by re-estimating the baseline model given by Equation (4) using log of total internally displaced persons. The re-estimated results can be found in Table 5. The coefficients (Panel A) and marginal effects (Panel B) of log oftotal internally displaced persons are all positive but statistically significant at the one and five percent significance levels for Enpov 2 and Enpov 3 only. All else equal, a 1 percent increase in the number of total internally displaced persons in a given year increases the probability of energy poverty by 0.13 and 0.55 percentage points. Specifically, each year, the incidence of lower access to clean cooking fuels and technologies rises by 0.13 percentage points; and lower access to electricity rises by 0.55 percentage points. It is important to note that internal conflicts often linger for years, if not decades, and quickly amass immense numbers of internally displaced persons—or 'internal refugees' (see, e.g., Geissler, 1999; Mooney, 2005; Cohen, 2006; Moore and Shellman, 2006)—and the competition for limited (potentially diminishing) resources, services, and technologies. Therefore, despite the minuscule aggravation of energy poverty as per the regression, the rapid jump in internally displaced persons coupled with the persistence of internal conflicts can quickly accumulate to a substantial impact on the different dimensions of energy poverty in a given country. This finding (from Table 5), which is unprecedented in the extant literature, substantiates the sub-component hypothesis ***H1a**: A larger stock of persons displaced internally due to armed conflict(s) aggravates the extent of energy poverty in affected national economies*—as well as the overarching hypothesis ***H1**: Armed (internal) conflict increases energy poverty in countries that experience conflict.*

In sum, the baseline (model) findings from Tables 3–5 provide empirical evidence for hypothesis ***H1*** and its constituent component ***H1a***. These are novel and unique contributions to the literature and highlight an important political-economic factor—internal conflict—that determines energy poverty within national economies. As such, we identify an additional adverse impact of armed (internal) conflict on the economic outcome(s) of a national economy.

4.2. Addressing endogeneity concerns

Since conflicts are often blamed on scarce resources (as well as environmental degradation), the question of internal conflict being endogenously determined within baseline regression estimates in Tables 3–5 may arise (Theisen, 2008). Consequently, we re-estimate model equation (4) using Lewbel's (2012) heteroscedasticity-identified endogenous variable regression estimator and present the results in Table 6. As can be seen, internal conflict has positive and statistically significant effects on the three energy poverty indicators at the one percent levels of significance. The magnitudes of the coefficients from the Lewbel (2012) method, however, are smaller than that of the panel logistic regression estimators (in Tables 3–5)—which is to be expected as the former does not implement a logistic model. The internally generated instruments under the Lewbel (2012) estimator pass the identification tests, as the Kleibergen-Paap under-identification test is rejected for all three models. Overall, the above results corroborate the novel finding—and hypothesis ***H1*** for that matter—that the occurrence of internal conflict increases all three dimensions of energy poverty in our sample.

To address the added concerns about endogeneity, we re-estimate the baseline model equation (4) using the probit estimator

Table 5
Effect of internally displaced persons due to conflict and violence on various measures of energy poverty.

Panel A: Regression Estimates

Explanatory variables	Dependent variable		
	Enpov 1 (1)	Enpov 2 (2)	Enpov 3 (3)
logTotal internally displaced persons	0.0695	0.0972**	0.0695***
	(0.0448)	(0.0426)	(0.0224)
Age dependency ratio, old	−0.292***	−0.686***	−0.0942***
	(0.0783)	(0.239)	(0.0227)
Consumer price index	0.0316***	−0.00426	0.00578**
	(0.00759)	(0.0125)	(0.00231)
Current account balance	−0.0311	−0.0695*	−0.0258
	(0.0276)	(0.0378)	(0.0163)
logGDP per capita	−1.256*	−1.276***	−0.730***
	(0.644)	(0.259)	(0.179)
Labor force participation rate	0.00181	0.193***	0.0483***
	(0.0240)	(0.0396)	(0.0125)
Manufacturing, value added	0.0448**	0.0606	0.108***
	(0.0217)	(0.0593)	(0.0214)
Research and development expenditure	−0.824*	−0.307	−1.095***
	(0.473)	(0.847)	(0.233)
Long/short-term orientation	0.00739	−0.0481***	−0.0328***
	(0.0107)	(0.0135)	(0.00460)
Observations	1112	1231	1606
Number of countries	90	93	94
Time Fixed Effects	Yes	Yes	Yes

Panel B: Marginal Effect of logTotal internally displaced persons

logTotal internally displaced persons	0.0028	0.0013**	0.0055***
	(0.0019)	(0.00057)	(0.0018)

Notes: Panel A: Robust standard errors in parentheses; Panel B: Delta-method standard errors in parentheses.
***, **, & * indicate statistical significance at the 1, 5, & 10 levels of significance.

Table 6
Effect of internal conflict on various measures of energy poverty using the Lewbel (2012) estimator.

Explanatory variables	Dependent variable		
	Enpov 1	Enpov 2	Enpov 3
	(1)	(2)	(3)
Internal conflict	0.183***	0.0145	0.177***
	(0.0472)	(0.0301)	(0.0411)
Age dependency ratio, old	−0.00970***	−0.00668***	−0.0115***
	(0.00130)	(0.000892)	(0.00117)
Consumer price index	−0.000401	−0.000336***	−0.000754***
	(0.000329)	(0.000126)	(0.000273)
Current account balance	−0.00289***	−0.00300***	−0.00167
	(0.000947)	(0.000788)	(0.00132)
logGDP per capita	−7.72e-07*	−1.53e-06***	−3.50e-06***
	(4.17e-07)	(2.98e-07)	(5.13e-07)
Labor force participation rate	−0.000545	0.00522***	0.00393***
	(0.00156)	(0.000882)	(0.00144)
Manufacturing, value added	−0.00362***	−0.00427***	0.00547***
	(0.00128)	(0.000980)	(0.00176)
Research and development expenditure	−0.00169	0.0120**	−0.0430***
	(0.00950)	(0.00602)	(0.0101)
Long/short-term orientation	−1.94e-05	−0.000880***	−0.00350***
	(0.000375)	(0.000197)	(0.000418)
Constant	0.373***	−0.0398	0.409***
	(0.107)	(0.0470)	(0.109)
Observations	1146	1431	1606
Number of countries	90	93	94
Kleibergen-Paap rk LM Test [a]	209.38***	274.96***	295.18***

Notes: Robust standard errors in parentheses. The first lag of internal conflict is used as an additional instrument.
***, **, & * indicate statistical significance at the 1, 5, & 10 levels of significance.
[a] Kleibergen-Paap rk LM test verifies the under-identification of the instrument(s) in the respective Lewbel (2012) estimates. H_0: Instrument uncorrelated with endogenous regressor(s) and model is under-identified.

incorporating cultural diversity as an instrumental variable. The second stage probit estimates are reported in Table 7. As can be seen, the coefficients are all positive and statistically significant at the 1 per cent level. Thus, when instrumented for any potential bias due to endogeneity, the probit estimates in Table 7 corroborate the energy poverty (all three dimensions) worsening attribute of a country's internal conflict(s). These findings further substantiate the baseline estimates (evidence for hypothesis ***H1****: Armed (internal) conflict increases energy poverty in countries that experience conflict*) in Tables 3–5 and that of the endogeneity-corrected Lewbel (2012) estimates.

Despite addressing endogeneity using Lewbel's (2012) and instrumental variable approach, supplementary concerns about the identification of model (4) and estimation of the causal effect of conflict on three dimensions of energy poverty may remain. Such concerns can be alleviated by estimating the ATT of internal conflict on the energy poverty measures using the PSM and Entropy Balancing methods. As can be seen from Panels A and B of Table 8, the estimated ATT coefficients of Internal Conflict are all positive and statistically significant at 1 and 5 per cent levels of significance. The ATT coefficient estimates are also virtually identical in magnitude under both estimation methods. The ATT coefficient magnitudes are, on average, also smaller than those in Tables 3, 4 and 7, larger than those in Table 5, and similar to those in Table 6. Figures B1 and B2 and Table B2, in Appendix B2., indicate that treatment and control groups assigned under the PSM and Entropy Balancing methods are virtually identical statistically. The ATT estimates from Table 8 prove that the energy poverty-aggravating impact of internal conflict (and evidence for hypothesis ***H1***) remains (econometrically) veracious and is not vulnerable to identification issues.

Lastly, we perform the Oster (2019) test for omitted variable bias and parameter stability as part of the check for the robustness of the above results. The Oster (2019) test estimates for the three energy poverty proxies are presented in Table B1 (Appendix B.). As can be seen, the estimated coefficients of internal conflict on energy poverty remain positive in both the restricted and full models for all three variants of equation (4). The difference between the restricted and full model coefficients ($\beta_{\text{Restricted}} - \beta_{\text{Full}}$) of internal conflict remains relatively low—in columns 2, 4, & 6, Table B1. The difference in the explanatory powers of the restricted and full models ($R_{\text{Full}} - R_{\text{Restricted}}$), however, remains considerable 0.279, 0.036, and 0.349 for Enpov 1, Enpov 2, and Enpov 3 as the dependent variable of equation (4), respectively. This implies the necessity of the model (4) control variables. The bias-adjusted coefficients (β^*) of internal conflict remain positive for all three variants of model equation (4). Furthermore, the coefficient of proportionality (δ) is greater than one (1) in magnitude in all three instances—implying the robustness of the estimated (positive) impact of internal conflict on the three energy poverty proxies. Accordingly, the estimated models presented in Tables 3–6 are observed (in Table B1, Appendix B.) to be free from omitted variable bias, and the estimated coefficients of internal conflict are (statistically) stable. Thus, the findings and subsequent inferences made from the above results remain valid. The econometric evidence for hypothesis ***H1*** continues to remain in force.

Table 7
Effect of internal conflict on various measures of energy poverty using cultural diversity as an instrument.

Explanatory variables	Dependent variable		
	Enpov 1	Enpov 2	Enpov 3
	(1)	(2)	(3)
Internal conflict	3.454***	3.574***	2.223*
	(0.0832)	(0.124)	(1.218)
Age dependency ratio, old	0.0687	0.0219	−0.0647
	(0.0652)	(0.121)	(0.0992)
Consumer price index	0.595	−1.134	−1.664***
	(0.930)	(0.737)	(0.607)
Current account balance	−0.0634	−0.217**	−0.0715
	(0.0783)	(0.109)	(0.112)
logGDP per capita	0.0655	−0.374	−0.622
	(0.216)	(0.599)	(0.485)
Labor force participation rate	0.166***	0.257***	0.259***
	(0.0495)	(0.0655)	(0.0711)
Manufacturing, value added	−0.0894*	−0.166**	0.185
	(0.0471)	(0.0704)	(0.147)
Research and development expenditure	−0.585***	−1.060**	−0.441***
	(0.136)	(0.470)	(0.116)
Long/short-term orientation	0.106*	−0.145	−0.318
	(0.0598)	(0.213)	(0.218)
Constant	−1.428***	−2.472**	−1.020***
	(0.265)	(1.020)	(0.169)
Observations	1076	1348	1498
Number of countries	84	88	88

Notes: Robust standard errors in parentheses.
***, **, & * indicate statistical significance at the 1, 5, & 10 levels of significance. Standardized values of the control variables are used.

Table 8
Average treatment effect on the treated (ATT) of internal conflict on energy poverty.

	Enpov 1	Enpov 2	Enpov 3
Panel A: Propensity Score Matching using Nearest Neighbor match			
Internal conflict	0.173***	0.089**	0.164***
	(0.0494)	(0.035)	(0.048)
Panel B: Entropy balancing			
Internal conflict	0.182***	0.066**	0.176***
	(0.043)	(0.028)	(0.040)

Notes: Panel A: Nearest-neighbor matching is used (10 neighbors), by considering a pair of observations a match if the absolute difference in the propensity score is less than 0.005 (half a percentage point).
***, **, & * indicate statistical significance at the 1, 5, & 10 levels of significance.

4.3. Robustness checks

We continue checking for the robustness of the above findings by re-estimating the model equation (4) using the internal conflict measure from the ICRG. These re-estimated results can be found in Table 9. The estimated negative coefficients, significant at the conventional levels (1 and 5 percent), indicate that internal conflict aggravates energy poverty—as higher values of the former denote a lower risk of internal conflict. The marginal effects of internal conflict on energy poverty are positive, but somewhat smaller than that of Tables 3–5 Ceteris paribus, energy poverty due to lower energy use rises by 11.6 percentage points; lower access to clean cooking fuels and technologies rises by 0.73 percentage points; and lower access to electricity rises by 1.5 percentage points due to internal conflict each year.

Table 9
Robustness check—effect of internal conflict on various measures of energy poverty using the ICRG measure of internal conflict (Higher values mean lower risk of internal conflict).

Panel A: Regression Estimates			
Explanatory variables	Dependent variable:		
	Enpov 1 (1)	Enpov 2 (2)	Enpov 3 (3)
Internal conflict	−0.448***	−2.168***	−0.238**
	(0.123)	(0.686)	(0.0986)
Age dependency ratio, old	0.402	3.011	−0.386**
	(0.599)	(1.911)	(0.152)
Consumer price index	28.61***	24.46	2.860**
	(7.820)	(32.67)	(1.441)
Current account balance	−0.190	−0.0533	−0.448*
	(0.558)	(1.136)	(0.264)
logGDP per capita	−6.392***	−24.71***	−2.452***
	(0.952)	(6.752)	(0.204)
Labor force participation rate	−0.228	4.461***	0.586***
	(0.220)	(0.927)	(0.169)
Manufacturing, value added	0.548**	−0.425	0.460***
	(0.253)	(0.720)	(0.176)
Research and development expenditure	−2.209*	−36.51***	−0.923***
	(1.188)	(7.850)	(0.287)
Long/short-term orientation	−0.885***	−1.417	−0.735***
	(0.331)	(1.144)	(0.127)
Constant	−0.440	−37.61***	2.221*
	(1.824)	(8.512)	(1.237)
Observations	969	1096	1499
Number of countries	79	77	78
Time Fixed Effects	Yes	Yes	Yes
Panel B: Marginal Effect of Internal Conflict			
Internal conflict	−0.116***	−0.0073***	0.015**
	(0.003)	(0.002)	(0.006)

Notes: Panel A: robust standard errors in parentheses; Panel B: Delta-method standard errors in parentheses.
***, **, & * indicate statistical significance at the 1, 5, & 10 levels of significance. Standardized values of the control variables are used.

The estimates in Table B1 (Appendix B.) and Tables 7–9 present robust evidence of the energy poverty-aggravating effect of armed (internal) conflict—warranting hypothesis ***H1****: Armed (internal) conflict increases energy poverty in countries that experience conflict.*

The final test for robustness involves determining the impact of internal conflict intensity—as measured by the Bertelsmann Transformation Index—on the three energy poverty proxies. The estimated results from such regressions (equation (4)) are displayed in Table 10. The estimated coefficients (in Panel A) of the three levels of conflict intensity (high, medium, and low) are positive and statistically significant for all three energy poverty measures—except for that of 'Conflict intensity - low' in column (1), which could not be estimated due to insufficient observations. The estimated marginal effects (in Panel B) remain positive and significant. Specifically, the magnitudes of the marginal effects are generally the highest for a medium-intensity conflict, with high-intensity conflict having slightly smaller marginal effects.

For a country experiencing high or medium-intensity conflict, the probability of it being energy poor as captured by Enpov 1, increases by 19.8% and 20.1%, respectively, compared to if there is no conflict. Similarly, a country experiencing high, medium, or low-intensity conflict increases the probability of it being energy poor as captured by Enpov 2 by 7.1, 4.4, and 5.6 percentage points compared to if there is no conflict. Lastly, the probability of a country being energy poor, as captured by Enpov 3, increases by 110.6, 102.6, and 106.7 percentage

Table 10
Robustness check—effect of internal conflict intensity (dummy variables) on various measures of energy poverty using the Bertelsmann Transformation Index.

Panel A: Regression Estimates			
Explanatory variables	Dependent variable:		
	Enpov 1 (1)	Enpov 2 (2)	Enpov 3 (3)
Conflict intensity - high	6.618*** (1.822)	7.807*** (1.350)	15.06*** (0.662)
Conflict intensity - medium	6.737*** (1.792)	4.769** (1.903)	13.96*** (0.441)
Conflict intensity - low	–[a]	6.166*** (1.678)	14.53*** (0.427)
Age dependency ratio, old	−0.806** (0.403)	−1.149 (1.659)	−0.312** (0.129)
Consumer price index	31.19*** (8.619)	−17.97 (13.53)	2.887 (1.763)
Current account balance	0.490 (0.385)	−0.430 (0.757)	0.0148 (0.193)
logGDP per capita	−5.258*** (0.580)	−6.897*** (1.081)	−1.932*** (0.173)
Labor force participation rate	−0.444** (0.179)	0.922** (0.410)	0.270** (0.127)
Manufacturing, value added	0.269 (0.243)	0.943 (0.610)	0.619*** (0.155)
Research and development expenditure	−1.618** (0.807)	−4.668*** (1.162)	−0.581*** (0.204)
Long/short-term orientation	−0.536*** (0.207)	−2.564*** (0.424)	−1.057*** (0.120)
Constant	−3.024** (1.292)	−12.18*** (1.913)	−1.119** (0.562)
Observations	1008	1231	1606
Number of countries	90	93	94
Panel B: Marginal Effect of Internal Conflict			
Conflict intensity - high	0.198*** (0.067)	0.071*** (0.024)	1.106*** (0.069)
Conflict intensity - medium	0.201*** (0.067)	0.044* (0.023)	1.026*** (0.062)
Conflict intensity - low	–[a]	0.056*** (0.022)	1.067*** (0.0618)

Notes: Panel A: robust standard errors in parentheses; Panel B: Delta-method standard errors in parentheses.
***, **, & * indicate statistical significance at the 1, 5, & 10 levels of significance. Standardized values of the control variables are used.
[a] This coefficient/marginal effect is not estimated due to insufficient observations.

points if a country is engulfed in high, medium, or low-intensity conflict, respectively, vis-à-vis if there is no conflict.

The above novel results present evidence for hypothesis ***H1b**: A greater intensity of armed (internal) conflict worsens energy poverty in conflict-ridden economies*, along with an interesting scenario. The greater impact of high- and medium-intensity conflict vis-à-vis intensity conflict is intuitive—as conflict increases, resource scarcity of resources/energy worsens. This novel finding is consistent with the literature that observes, both theoretically and empirically, the relationship between resource scarcity and conflict (e.g., Koubi et al., 2014; Nillesen and Bulte, 2014; Vesco et al., 2020). However, the impact of high conflict intensity is approximately the same as that of medium conflict intensity. This implies that beyond a certain threshold of conflict intensity—i.e., medium—energy supply chain and/or infrastructure breakdown, resulting in widespread energy poverty. Little is left to deprive and/or destroy regarding energy (access and/or use) when conflict intensity increases beyond this point (from medium to high).

4.4. Economic discussion

The overall finding from the preceding estimations is that armed (internal) conflicts worsen energy poverty across national economies. It is also observed that a larger extent of internally displaced persons or internal refugees and a greater intensity of conflict worsen a country's aggregate energy poverty scenario. This finding, along with its constituent observations, presents unprecedented, unique, and important implications for the literature on energy poverty and its determinants. The national economies experiencing such a phenomenon involve an interplay between armed conflict, scarcity of resources, and allocation of resources to engaging in and/or mitigating conflict—see, e.g., Deger and Sen (1983), Theisen (2008), Koubi et al. (2014), Aziz and Khalid (2019), inter alia. Armed conflict hampers economic growth and access to reliable fuels, technologies, and energy services. Conflict invariably reduces economic growth, private as well as public consumption and investment, trade, and sectoral value addition, leading to decreased household income and the reduced affordability of energy services. Conflict also hinders energy supply by destroying infrastructure, such as power plants, transmission lines, and fuel supply chains, causing energy scarcity, reduced availability, and difficulties in fuel transportation and distribution. Thus, armed (internal) conflicts hinder households' ability to access and utilize energy to attain desirable economic outcomes, deteriorating their respective economic standings as well as that of the national economy as a whole.

In addition, an armed conflict leads to an increase in military spending and, as such, requires substitution between civilian and military economic interests at the macroeconomic level. Reduced resource availability, coupled with reduced civilian productive (economic) capacity, leads to diminished consumption possibilities, including energy consumption at the macroeconomic front. Consequently, conflict aggravates energy poverty by reducing energy consumption as well as contracting access to electricity and clean cooking.

The scarcity, as well as the abundance, of natural resources, including that of renewables (biomass), have been associated with worsening conflict—e.g., Theisen (2008), Nillesen and Bulte (2014), Koubi et al. (2014), and Vesco et al. (2020), inter alia. DiGiuseppe et al. (2012) observe that improved access to credit mitigates internal conflict. As such, the roles of (unequal) distribution of resources as well as empowerment of various groups within society in determining conflict and, subsequently, energy poverty come to the fore. This is because energy poverty is often attributable to a lack of access to reliable access to appropriate fuels, technologies, and energy services.

An armed (internal) conflict thus leads to 'societal conflict' (or competition) over access and availability of energy and related technologies. Armed (internal) conflicts, thus, have a *Pareto efficient* outcome(s) regarding access to appropriate fuels, technologies, and energy services for national economies. The ensuing competition (for scarce resources) may also entail a Nash equilibrium where everyone in society (macro-economy) is worse off—energy deprived as well as (economically) impoverished.

5. Conclusion

Energy poverty remains a significant global concern, with approximately 13% of the world's population lacking access to electricity and 40% lacking access to safe and clean cooking fuels. The link between conflict and energy poverty is evident as economic activities decrease during times of conflict, resulting in reduced economic growth and disposable personal income. However, no previous study has undertaken a systematic analysis of internal conflict and energy poverty nexus at the global level.

This study addresses this gap in the current literature by exploring the relationship between internal conflict and energy poverty. Additionally, we investigate the impact of internally displaced persons on energy poverty. Using energy poverty data from the World Bank and data on internal conflict and internally displaced persons from the PRIO Database, our findings indicate that internal conflict and internally displaced persons contribute to increased energy poverty within and between economies. This increase is due to reductions in energy consumption, limited access to electricity, and clean cooking. Furthermore, conflicts result in an increase in military expenditures, which in turn necessitates resource allocation between civilian and military interests.

To address endogeneity concerns, we use Lewbel's (2012) heteroscedasticity-identified endogenous variable regression estimator, the probit estimator incorporating "cultural diversity" as an instrumental variable and also estimate the ATT of internal conflict on the energy poverty measures using the Propensity Score Matching (PSM) and Entropy Balancing methods. Overall the results from all these exercises indicate the incidence of internal conflict worsens energy poverty, thus underscoring the robustness of our results.

Our study shows that conflict can exacerbate energy poverty, offering several policy implications. First, as conflict worsens energy poverty, its prevention, and peaceful resolution are among the most effective ways of addressing energy poverty. Governments and international organizations, including the United Nations (UN), should prioritize efforts to prevent and mediate conflicts, given that prolonged conflicts can disrupt energy infrastructure, hinder investment, and impede the delivery of energy services to affected populations.

Second, policies should focus on protecting the critical energy infrastructure and ensuring rapid restoration and repair in conflict-affected areas. During conflicts, energy infrastructure, such as power plants, transmission lines, and fuel supply chains, are often targeted or damaged. Strengthening security measures, establishing contingency plans, and investing in post-conflict reconstruction efforts are some measures that can be taken. Furthermore, an international treaty that identifies energy as a basic right and provides guidelines—perhaps similar to *The Water Convention and the Protocol on Water and Health*—for safeguarding energy sources, infrastructure, and services may be developed. This is likely to assist in formulating the abovementioned policies at the national level.

Third, governments should prioritize the diversification of energy sources and supply chains to reduce the risk of energy poverty during conflicts. Overreliance on a single energy source or supplier can render energy systems vulnerable to disruptions caused by conflicts. Promoting renewable energy alternatives, exploring regional energy cooperation, and fostering energy independence through domestic resource development are some measures that could be taken. Here, too, the role of international entities such as the UN and regional blocs, as well as relevant treaties and conventions noted there above, is important in fostering a diversified energy mix within and across nations.

Fourth, conflict often leads to displacement and humanitarian crises, which results in affected populations facing increased energy poverty. Governments, international organizations, and NGOs should prioritize providing humanitarian assistance that includes access to safe, reliable, and affordable energy services, in accordance with pertinent current and recommended future international treaties and conventions. Deploying off-grid renewable energy solutions, providing fuel-efficient cooking stoves, and establishing temporary energy infrastructure in refugee camps and internally displaced persons (IDP) settlements are some of the measures that could be taken. A comprehensive and appropriate roadmap for energy security, especially during times of internal conflict, is essential for policymakers within and across nations.

Fifth, conflicts can severely weaken the governance structures, regulatory frameworks, and institutional capacities in the energy sector. Capacity-building initiatives and institutional strengthening should be included in policy formulations to ensure effective energy planning, management, and regulation in post-conflict scenarios. Training local personnel, enhancing regulatory frameworks, and promoting good governance practices in the energy sector are some measures that can be taken. Economies afflicted by ongoing conflict and/or recovering from conflict often will not have the capacity to undertake the above recommendations. In this regard, the international community, including developed economies, have a duty to cooperate with and assist such economies. This may be achieved via knowledge-sharing programs such as international training programs and workshops, merit-based scholarships for higher studies, government- and business-level cooperations, and technology transfer, inter alia.

Finally, addressing the energy poverty aggravated by conflict requires international, including regional, cooperation and support. The international community should provide financial assistance, technical expertise, and policy guidance to conflict-affected countries. This support can help to build resilient energy systems, facilitate post-conflict reconstruction, and promote sustainable development, ultimately reducing energy poverty in conflict-affected areas. Therefore, international cooperation, coordination, and support should be prioritized.

While our results robustly establish the link between internal conflict and energy poverty, further analysis can help shed light on the different dimensions of conflict-energy poverty nexus. For instance, future studies can extend the analysis to other types of conflicts—i.e., external conflict or interstate conflict. Future studies can also explore the conflict-energy poverty nexus using other measures of energy poverty—such as appliance ownership and access to heating (in the winter), amongst others. In this study, due to data limitations, we have undertaken the analysis using three measures of energy poverty, which are commonly used in the literature. However, future studies can study this relationship using multidimensional measures of energy poverty to provide further insights into the conflict-energy poverty nexus. It may also be useful to examine the conflict-energy poverty nexus at the micro-level using survey and/or experimental data.

CRediT authorship contribution statement

Usman Khalid: Writing – review & editing, Writing – original draft, Methodology, Formal analysis, Data curation, Conceptualization. **Muhammad Shafiullah:** Writing – review & editing, Writing – original draft, Investigation, Data curation, Conceptualization. **Sajid M. Chaudhry:** Writing – review & editing, Writing – original draft.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

Acknowledgment

This study is supported by United Arab Emirates University under the UPAR grant (# 12B049). The authors would like to thank Huda Ubaid for her assistance in the research.

Appendix A

Table A1
List of countries

Albania	Ghana	Oman
Algeria	Hungary	Pakistan
Armenia	Iceland	Paraguay
Australia	India	Peru
Austria	Indonesia	Philippines (the)
Azerbaijan	Iraq	Poland
Belarus	Ireland	Portugal
Belgium	Israel	Romania
Bolivia	Italy	Russian Federation (the)
Bosnia and Herzegovina	Japan	Rwanda
Brazil	Jordan	Saudi Arabia
Burkina Faso	Kazakhstan	Senegal
Cambodia	Korea (the Republic of)	Serbia
Canada	Kyrgyzstan	Singapore
Chile	Latvia	Slovakia
China	Lithuania	Slovenia
The Democratic Republic of Congo	Luxembourg	South Africa
Colombia	Malaysia	Spain
Czechia	Mali	Sri Lanka
Croatia	Malta	Sweden
Czechia	Mexico	Switzerland
Denmark	Moldova (the Republic of)	Tajikistan
Egypt	Montenegro	Tanzania, the United Republic of
El Salvador	Morocco	Thailand
Estonia	Mozambique	Trinidad and Tobago
Finland	Netherlands (the)	Turkey
France	New Zealand	Uganda
Georgia	Nicaragua	Ukraine
Germany	Nigeria	United Kingdom
Greece	North Macedonia	United States of America
Hong Kong	Norway	Uruguay
	Viet Nam	Zambia

Note: Total = 94 countries.

Appendix B

Table B1
Robustness check—Oster (2019) test for omitted variable bias and coefficient stability

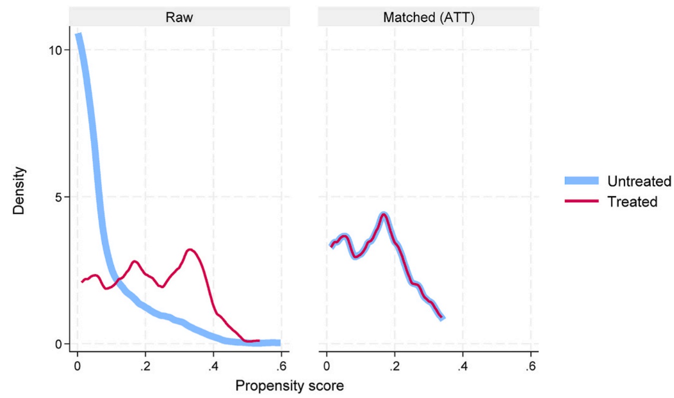
Independent variable	Dependent variable:					
	Enpov 1		Enpov 2		Enpov 3	
	Restricted	Full model	Restricted	Full model	Restricted	Full model
	(1)	(2)	(3)	(4)	(5)	(6)
Internal conflict	0.226	0.072	0.107	0.105	0.357	0.098
Controls	NO	YES	NO	YES	NO	YES
Constant	YES	YES	YES	YES	YES	YES
No. of observations	1146	1146	1431	1431	1606	1606
R^2 (WITHIN)	0.072	0.351	0.084	0.12	0.083	0.432
R_{Max}		0.456		0.156		0.562
$\beta_{Restricted} - \beta_{Full}$ Internal conflict		0.154		0.001		0.259
$R_{Max} - R_{Full}$		0.105		0.036		0.130
$R_{Full} - R_{Restricted}$		0.279		0.036		0.349
Bias adjusted coefficient (β^*) ($R_{Max} = R_{Full} + (R_{Full} - R_{Restricted})$) Internal conflict		0.014		0.104		0.002
Coefficient of proportionality (δ) [a] ($R_{Max} = \min(1.3R_{Full}, 1)$) Internal conflict		**1.240**		**79.143**		**1.020**

Notes: The Oster (2019) tests are performed by estimating equation (4)using panel fixed effects regressions.
R_{Max} is the estimated R^2 of the coefficient from hypothetical regression that includes both observed and unobserved factors. R_{Full} is the estimated R^2 of the coefficient from a regression that includes a full set of observed control variables. $R_{Restricted}$ is the estimated R^2 of the coefficient from a regression that includes only the dependent variable and the main independent variable.
[a] $\delta > 1$ indicates that the estimated coefficient is robust, which is highlighted in **bold font**.

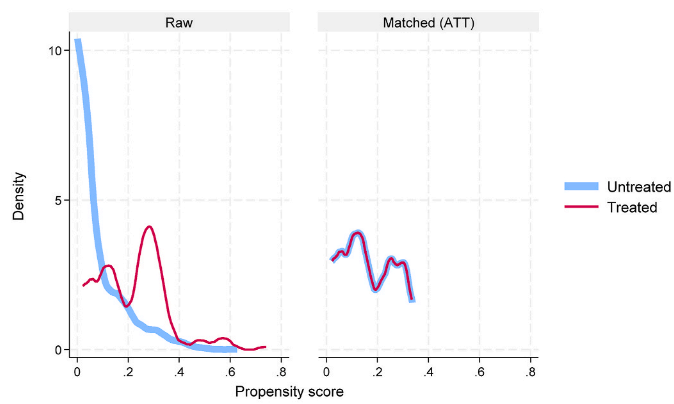
Table B2
Robustness check—effect of internal conflict intensity on various measures of energy poverty using the Bertelsmann Transformation Index

	Dependent variable		
Explanatory variables	Enpov 1	Enpov 2	Enpov 3
Conflict Intensity	0.402***	0.338*	0.226***
	(0.139)	(0.184)	(0.0772)
Age dependency ratio, old	−0.283***	−0.690***	−0.0856***
	(0.0780)	(0.256)	(0.0211)
Consumer price index	0.0302***	−0.00824	0.00484**
	(0.00808)	(0.0134)	(0.00223)
Current account balance	−0.0333	−0.0644*	−0.0235
	(0.0288)	(0.0348)	(0.0161)
Log GDP per capita	−1.223*	−1.263***	−0.709***
	(0.670)	(0.259)	(0.172)
Labor force participation rate	0.00463	0.195***	0.0502***
	(0.0238)	(0.0402)	(0.0126)
Manufacturing, value added	0.0439*	0.0609	0.103***
	(0.0229)	(0.0575)	(0.0212)
Research and development expenditure	−0.755	−0.586	−1.096***
	(0.479)	(0.829)	(0.228)
Long/short-term orientation	0.00812	−0.0464***	−0.0335***
	(0.0113)	(0.0129)	(0.00453)
Observations	1112	1231	1606
Time FE	Yes	Yes	Yes

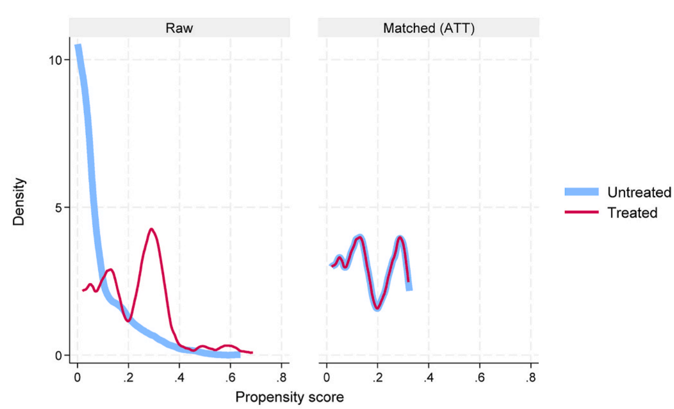
Notes: Robust standard errors in parentheses.
***, **, & * indicate statistical significance at the 1, 5, & 10 levels of significance.



Panel A: Dependent variable = Enpov 1

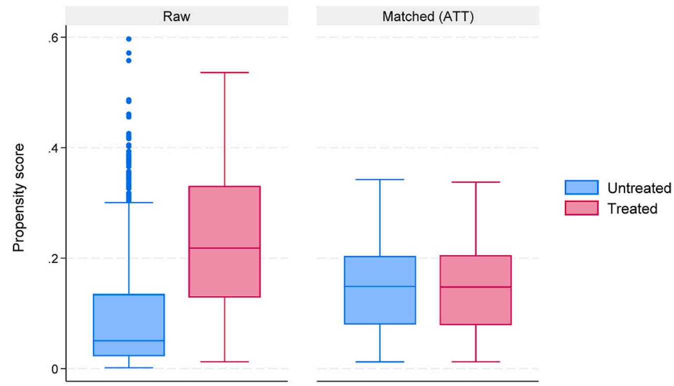


Panel B: Dependent variable = Enpov 2

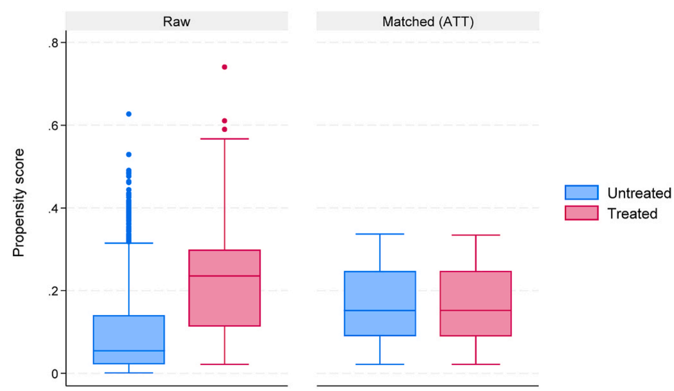


Panel C: Dependent variable = Enpov 3

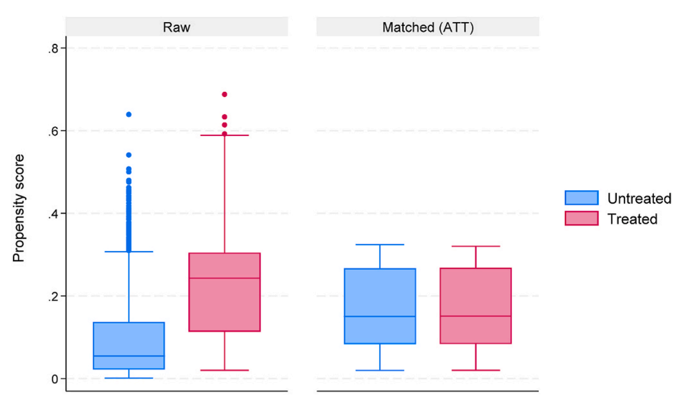
Fig. B1. Density Balancing Plot for Propensity Score Matching



Panel A: Dependent variable = Enpov 1



Panel B: Dependent variable = Enpov 2



Panel C: Dependent variable = Enpov 3

Fig. B2. Balancing Box Plot for Propensity Score Matching

Table B3
Comparison of Means for Estimating the Average Treatment Effect on the Treated (ATT) of Internal Conflict on Energy Poverty using Propensity Score Matching

	Raw			Matched (ATT)		
	Treated	Untreated	Standardized difference	Treated	Untreated	Standardized difference
	Dependent variable = Enpov **1**					
Age dependency ratio, old	10.44	17.08	−1.00	10.44	10.44	−1.64E-14
Consumer price index	79.34	87.67	−0.30	79.34	79.34	−1.53E-15
Current account balance	−0.73	−0.70	0.00	−0.73	−0.73	2.01E-15

(*continued on next page*)

Table B3 (*continued*)

	Raw			Matched (ATT)		
	Treated	Untreated	Standardized difference	Treated	Untreated	Standardized difference
GDP per capita growth (annual %)	3.26	2.72	0.15	3.26	3.26	8.76E-16
Labor force participation rate	63.71	68.76	−0.57	63.71	63.71	−5.59E-15
Manufacturing, value added	16.45	14.95	0.25	16.45	16.45	1.20E-15
Research and development expenditure	0.89	1.06	−0.16	0.89	0.89	−4.86E-15
	Dependent variable = Enpov **2**					
Age dependency ratio, old	10.72	17.78	−0.96	10.72	10.72	2.41E-16
Consumer price index	109.08	106.21	0.06	109.08	109.08	0
Current account balance	−0.91	−0.55	−0.05	−0.91	−0.91	−3.22E-17
GDP per capita growth (annual %)	2.99	2.32	0.18	2.99	2.99	1.19E-16
Labor force participation rate	63.91	69.52	−0.60	63.91	63.91	0
Manufacturing, value added	16.14	14.06	0.34	16.14	16.14	0
Research and development expenditure	0.89	1.06	−0.16	0.89	0.89	0
	Dependent variable = Enpov **3**					
Age dependency ratio, old	10.69	17.73	−0.97	10.69	10.69	−2.84E-14
Consumer price index	104.69	102.05	0.06	104.69	104.69	−2.98E-16
Current account balance	−1.02	−0.67	−0.05	−1.02	−1.02	1.71E-15
GDP per capita growth (annual %)	2.96	2.37	0.16	2.96	2.96	8.50E-16
Labor force participation rate	63.72	69.48	−0.63	63.72	63.72	−1.09E-14
Manufacturing, value added	16.10	14.39	0.29	16.10	16.10	1.20E-15
Research and development expenditure	0.90	1.06	−0.16	0.90	0.90	−7.21E-15

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