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# Democracies Prioritize Sustainability as Energy Use Declines

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**Abstract**

We develop a theoretical framework to characterize the relationship between democracy and energy use on a global scale. We utilize the generalized method of moments (GMM) model to control for endogeneity on a balanced, global panel dataset encompassing 61 countries across six geographic regions. Contrary to conventional understanding that democracies may have a positive association with energy use, our findings reveal that democracy has a significant negative association with energy use. We conclude that democracies prioritize sustainability globally as energy use declines. These novel results are justified because democracies can often foster a culture of environmental awareness through active civil societies and open public discourse. This can lead to public pressure on governments to enact stricter environmental regulations and prioritize energy conservation. Our results highlight previously under-explored connections between democracy, social capital and energy consumption, paving the way for future research and policy development.

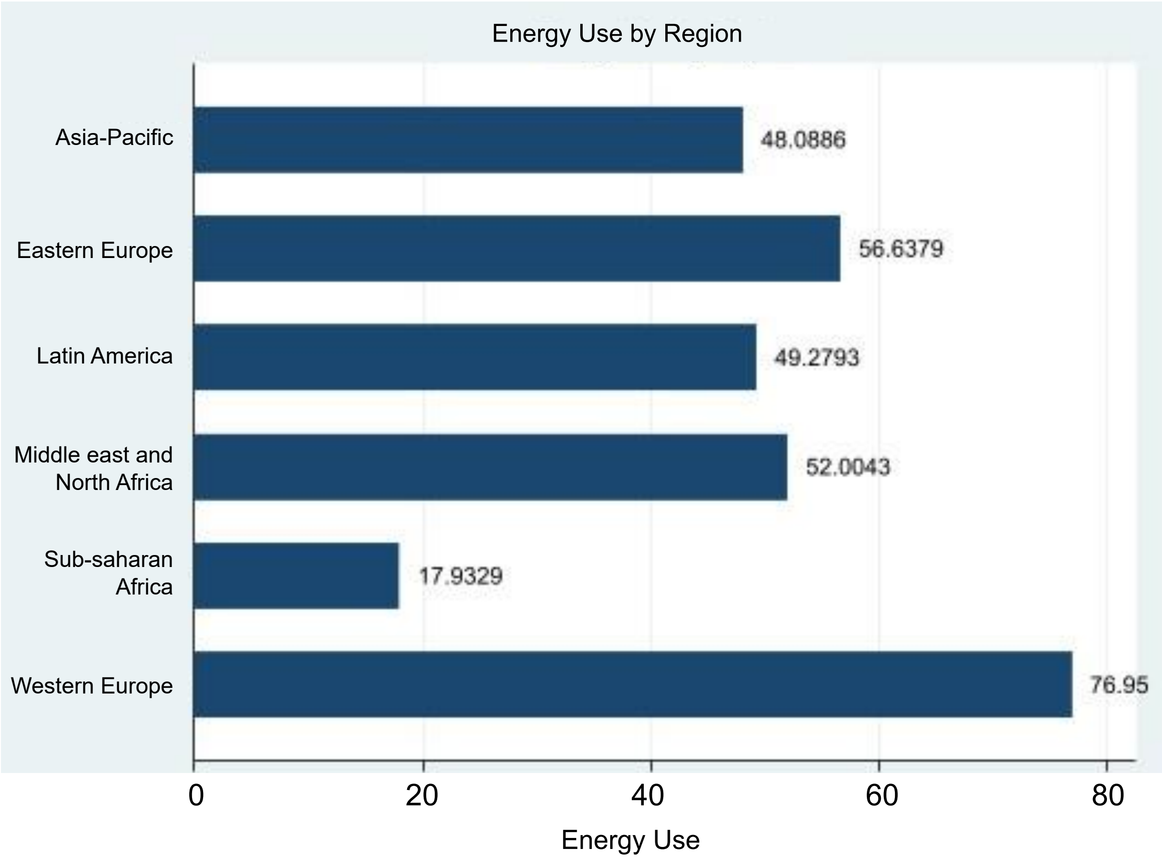
**Keywords:** Population, natural environment, democracy level, social capital, energy use
**JEL Classification:** P16, Q43, O13, C33

# 1. Introduction

Some political economists, such as Burke and Stephens (2018) and Thombs (2019) have proposed a model which assumes that democratizing the energy system can lead to more sustainable, equitable and participatory energy practices. The energy democracy theory is well established; for example, Szulecki (2018) provided much evidence of the importance of energy democracy in promoting transparency in energy planning, decision-making processes and the management of energy resources, yet institutional economists are cautious about institutional challenges associated with it as elaborated by Szulecki and Overland (2020). Energy democracy (particularly in developing/middle income countries such as India) faces challenges such as centralised governance, fragmented and weakly implemented regulations and socio-economic, regional or gender inequalities (Esping-Andersen *et al*., 1991; Pavlinek, 2002; Roženský, 2012; Szabó, 2022).

Marginalised (poor) communities lack resources to engage in energy projects, while institutional challenges of countries, including limited-access social order and political authorities having vested interests, hinder reforms. Addressing these challenges is not an easy process and it requires research that ensures equitable and sustainable energy access. Droubi *et al*. (2022) concluded that this theory does not cater for the real-world challenges of implementing energy democracy within existing power structures. Furthermore, it also questions the capacity of institutions to handle the complexities of democratic energy decision-making (Welton, 2018), which may vary in different regional groups, depending heavily on the stark differences in their energy consumption patterns (see Figure 1). We believe that their conclusions were partially true but were also strongly influenced by their focus on democracy influencing energy use, and later economic growth, only in certain ways, and that these hypotheses influenced the construction of their empirical investigations. Research that could help assess the relative strengths of this theory and institutional explanations of energy use must use such methods that incorporate the impact of democracy on energy use while incorporating a minimum of maintained hypotheses. Hansen (1982) can be seen as a methodology for testing the validity of maintained hypotheses of this model, which carefully address endogeneity issues that may emerge due to inclusion of institutional variables such as democracy (Aslam and Zulfiqar, 2016).

**Figure 1: Average energy use by regions (2008–2021)**




Source: Authors' own elaboration using data from Legatum Index

Figure 1 illustrates energy usage across regions from 2008 to 2021. Western Europe leads with a score of 77% due to developed economies, industrialization and high living standards (Bending *et al*., 1987). Eastern Europe follows with 57%, relying on coal and Soviet-era heavy industries (Nag *et al*., 2017). The Middle East ranks third (52%) due to abundant oil and gas reserves (Khan, 2016). Latin America and Asia-Pacific score 49% and 48% respectively, driven by economic growth and urbanization (CEPAL, 2010). Sub-Saharan Africa scores lowest (18%) due to limited energy access, rural populations and low industrialization. Challenges also include inadequate infrastructure and reliance on traditional biomass (Wachira, 2013).

Sociologists who have worked closely with energy economists examine the presence or absence of a causal relationship between energy use and social capital and have often obtained inconclusive results (Bridger and Luloff, 2001; McMichael, 2007). Social inclusion plays an important role towards inclusive growth (Aslam and Shabbir, 2019). Where significant results supporting the social capital theory with energy use have been obtained, they sometimes contradict the postulates of traditional economic theories that prioritize individualistic rationality and market mechanisms (Lehtonen, 2004). The findings challenge assumptions that solely market-driven energy systems are the most efficient or effective in promoting efficient and environmentally friendly energy use. Evidence also suggests that market mechanisms (alone) may fail/not be very successful to address long-term challenges, such as sustainable energy access and drastic climate change (Farooq *et al*., 2019). This undoubtedly necessitates a more balanced and comprehensive approach that is inclusive of regulatory oversight and government investment in sustainable technologies (Raza and Aslam, 2020). We argue that these conclusions may ignore real-world data or be the result of inappropriate design of models, which ignores the impact of social capital on energy use.

The demand for energy on a global scale has experienced a consistent upward trajectory, owing a great deal to the population growth. As the global population continues to grow, the demand for energy resources escalates (Dincer, 2000). Amidst the rapid expansion of societies and the surge in urbanization, the demand for energy resources has reached unprecedented heights. This demand permeates diverse sectors such as transportation, manufacturing, residential and commercial domains. The interconnectedness between population growth and energy use becomes apparent as the global population continues to expand. Concurrently, the imperative of environmental sustainability and the pressing need to mitigate climate change affecting the natural environment have emerged as major concerns on the global agenda, where population growth also gives hopes in embarking on social capital. Parallel to the environmental dimension, the political landscape assumes a crucial role in shaping energy policies and practices (Deiss, 2004). Democratic societies or countries that belong to open-access social order systems (better institutions), characterized by transparency, accountability and citizen participation, tend to exhibit more informed and sustainable energy decision-making processes.

Furthermore, the influence of social capital on energy behaviour and collective action in the form of social capital cannot be underestimated and adds to one of the novel aspects of this research paper. Social capital, encompassing trust, social networks and civic engagement, plays a pivotal role in shaping attitudes and behaviour related to energy within communities (Bhandari and Yasunobu, 2009). The strength of social connections (Aslam *et al*., 2021), shared values and cultural norms significantly influence energy conservation practices, the adoption of renewable energy sources and the acceptance of energy-efficient technologies (Niamir *et al*., 2020). A comprehensive understanding of the intricate interplay between social capital (human capital) and energy use offers valuable insights into the role of community engagement, social dynamics and behavioural change in driving sustainable energy transitions (Aslam, 2020).

In this paper, we examine the rarely comprehensively explored relationship between energy use, social capital and democracy, while controlling for natural environment and population in the global macroeconomy between 2008 and 2021. GMM methodology was developed by Hansen (1982) for carrying out macroeconomic modelling having endogeneity issues due to the presence of instrumental variables such as democracy and hypothesis testing. The model does not include any variable to measure economic growth in results, due to the presence of multicollinearity with lagged energy use. This may signify that changes in gross energy use may mimic level of economic growth achieved by different regional groups. To account for these possibilities, we substitute lagged energy to cater for economic growth. We seek to achieve three main objectives: Firstly, to examine the intricate interrelationships between energy use and population, along with other variables including natural environment, democracy level and social capital. Secondly, to gain a comprehensive understanding of how these factors influence energy sustainability and environmental stewardship. Finally, to provide valuable insights and recommendations for policymakers, researchers and stakeholders for the formulation of effective strategies that address the pressing challenges of escalating energy demands while promoting societal well-being and environmental protection.

## 2. Literature Review

The literature review investigates the interconnectedness between energy use, the natural environment, democracy and social capital. Economists have examined the relationship between economic growth and its impact on the environment, known as the environmental Kuznets curve, along with energy use (Özokcu and Özdemir, 2017; Shahbaz *et al*., 2013a; Shahbaz *et al*., 2013b). Other researchers have focused on the role of democracy and renewable energy in reducing carbon emissions, as well as the effects of globalization, urbanization and financial development on energy consumption (Adams and Acheampong, 2019; Burke and Stephens, 2018; Dincer, 2000). One important aspect in the literature is the linkages between environmental pollution, economic growth and education expenditures (Yan *et al*., 2022). Katircioglu *et al*. (2014) conducted a study in Cyprus to investigate the impact of education on the environmental situation through energy use as a dependent variable. Their findings suggest positive linkages between education expenditures and environmental improvement (Yan *et al*., 2022). Another important study also looked into the role of financial inclusion towards growth which is inclusive in nature (Zulfiqar *et al*., 2016).

Kharb *et al*. (2024) explored how investment determinants relate to environmental sustainability. Kaur *et al*. (2024) analysed the interconnections between stock markets in BRICS and G7 nations. Jacob *et al*. (2023a; 2023b) examined the factors that either promote or hinder the adoption of sustainability in global value chains. Perannagari and Gupta (2022) assessed the intellectual landscape of research into artificial neural networks in the business sector. Furthermore, the literature has also explored the relationship between economic growth and renewable energy consumption. For instance, Grabara *et al*. (2021) analysed the relationship between economic growth, renewable energy consumption and direct foreign investments in Kazakhstan and Uzbekistan (Malinowski, 2021). Their findings indicate that there is a positive relationship between renewable energy consumption and economic growth, although the direction of the relationship varies among studies (Cvijović *et al*., 2020). Moreover, the literature has also explored the neutrality hypothesis, which suggests that there is no significant relationship between renewable energy consumption and economic growth (Alper and Oguz, 2016). However, fewer studies confirm this hypothesis compared to those confirming a positive or negative relationship. Furthermore, the literature review highlights a shift in research focus from single-country studies to multi-country studies over the past decade, particularly in the realm of energy and environmental economics. This trend aligns with previous literature reviews, indicating a recognition of the importance of considering multiple countries when examining the relationship between renewable energy consumption and economic growth (Cvijović *et al*., 2020).

The existing literature has primarily focused on the relationship between renewable energy consumption and economic growth, with most studies confirming a positive connection but differing in the direction of the relationship (Cvijović *et al*., 2020). Additionally, the literature has explored the neutrality hypothesis, which suggests no significant relationship between renewable energy consumption and economic growth. Despite the scarcity of studies on the impact factors of renewable energy consumption, abundant research has been conducted to analyse the relationship between renewable energy consumption and other variables, such as income and foreign investments (Tudor and Sova, 2021). These studies generally support the growth hypothesis, which suggests that an increase in renewable energy consumption leads to higher income or economic growth (Tudor and Sova, 2021). Moreover, the literature also suggests a bidirectional relationship between renewable energy consumption and economic growth, known as the feedback hypothesis (Tudor and Sova, 2021). For instance, Apergis and Danuletiu (2014) conducted a comprehensive analysis of the relationship between economic growth and renewable energy consumption for 80 countries and found mixed results, with a conservation hypothesis between non-renewable energy consumption and economic growth.

Energy use, population and the natural environment are interconnected factors that play a crucial role in shaping the sustainability and well-being of societies. Numerous studies have examined the relationship between energy use and its environmental impact. According to the literature, rising energy consumption has been identified as a significant driver of environmental degradation (Alahakoon *et al*., 2022; Asif and Muneer, 2007). These studies have shown a clear and positive correlation between energy consumption and greenhouse gas emissions. Pao and Tsai (2011), Nasir and Rehman (2011), Rasli *et al*. (2018) and Zaman *et al*. (2021) have further supported this correlation between energy consumption and environmental degradation. Their findings highlight the role of energy consumption in contributing to the release of greenhouse gases, which leads to climate change and other detrimental environmental impacts. In addition to energy consumption, population growth and economic development also have a significant influence on the natural environment.

Energy plays a critical role in economic and social development, making it an important aspect of governance and democracy. The literature on energy and democracy explores the relationship between energy use, democratic institutions and their impact on society (Chen *et al*., 2021). One aspect of this literature focuses on the energy democracy movement, which seeks to promote a transition towards a new economic model based on environmentally friendly practices, social justice and community-based development (Pietro, 2021).

The desire to redistribute power to society through the transformation of new and renewable energy is a central tenet of energy democracy theory. According to Burke and Stephens (2018), the world's energy system has significant influences on society's political, economic, institutional and socio-cultural realms. Esping-Andersen *et al.* (1991) discussed the three important political economies of the welfare state. Szabó (2022), on the same hand, examined the political economy of (il)liberal capitalism in Hungary and Poland. Roženský (2012) explored mandatory expenditures and fiscal policy flexibility instruments in the Czech Republic. Pavlinek (2002) also offered in-depth theoretical interpretations of post-communist transformations in Central and Eastern European regions. Another key area of research within the literature is the examination of how energy systems can either strengthen or weaken democracy. Socio-technical systems, which encompass the technological and social infrastructure of energy production and consumption, play a crucial role in shaping democratic processes.

For instance, Mitchell *et al*. (2015) highlighted the shift from coal to gas in the mid-20$^{th}$ century as a decisive factor in transforming power relations within society, leading to a weakening of the labour movement and an overall transformation of democracy. This transition is seen as an opportunity to challenge dominant power structures, enhance community participation and promote equitable access to energy resources. Moreover, the literature on energy and democracy recognizes the need to consider not only the technological aspects of renewable energy implementation but also the political dimensions (Healy and Barry, 2017). This includes understanding how power is distributed and manifested in political and energy systems. Additionally, energy democracy acknowledges that the social processes surrounding renewable energy implementation are equally important as the technology itself in terms of justice and sustainability. The literature on this topic also acknowledges the role of democracy and renewable energy in reducing carbon emissions and improving the natural environment. However, the effectiveness of democratic systems in promoting sustainable energy practices and mitigating environmental challenges requires closer scrutiny. It is important to critically evaluate the extent to which democratic institutions facilitate the adoption of renewable energy policies and foster active citizen participation in environmental decision-making processes.

Furthermore, our study is novel in that it explores the influence of democracy on global energy use, while carefully highlighting a significant and important negative association, unlike prior works on economic or technological factors (Meo and Adebayo, 2024; Özkan and Adebayo, 2024). Moreover, our study is different from the earlier studies on financial regulations, cleantech investments and environmental quality and provides a more comprehensive thesis on a global scale (Andrew *et al.*, 2024; Huang *et al.*, 2024). We have emphasized that democracy may foster sustainability through public discourse, civil society participation and applied environmental policies or strategies.

We provide a novel contribution to the existing literature mentioned above by examining the influence of social capital on energy use within a global context (and not just regional or of a few countries). The global data will encompass diverse regions with varying socio-economic and institutional structures, both exclusive and inclusive political and economic institutions. The above-mentioned research focused more on specific countries or regions, whereas our study provides a comprehensive analysis that integrates democracy and the natural environment as important variables alongside social capital. Another noteworthy novel insight of this article concerns the impact of social capital on energy use.

The literature emphasizes the linkages between environmental pollution, economic growth and education expenditures, showcasing the potential positive impact of education on environmental improvement. However, the literature review highlights the scarcity of comprehensive studies analysing the various factors influencing energy consumption, particularly at the global level. This knowledge gap calls for rigorous research that takes into account diverse socio-economic contexts such as social capital, political factors such as democracy and demographic factors such as population to provide a holistic understanding of the determinants of energy adoption and consumption patterns. It is important to critically assess the methodology and empirical evidence presented in the reviewed studies. Inconsistent findings regarding the relationship between energy consumption and economic growth, as well as the limited support for the neutrality hypothesis, raise questions about the robustness and generalizability of the conclusions. We aim to address methodological limitations, employing statistical techniques such as GMM, and utilize comprehensive global datasets to enhance the reliability and validity of the findings. We aim to address these limitations, which will contribute to a more robust understanding of energy sustainability through energy use and facilitate evidence-based decision-making for policymakers and stakeholders.

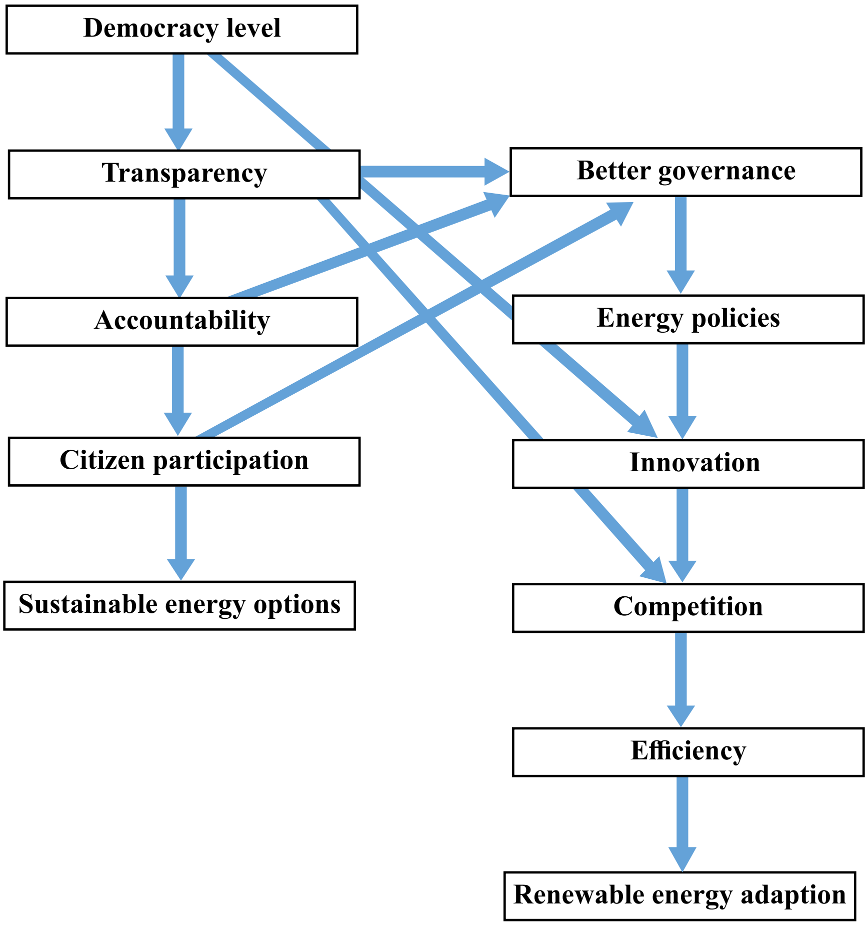
## 3. Conceptual Linkages

It appears from the literature review that the intricate connections between energy use, democracy and social capital have become an increasingly important subject of study, particularly as societies strive for sustainable development goals and equitable resource allocation. Energy use lies at the core of the modern world, enabling economic growth, technological advancements and improvements in the overall quality of life. Democracy, on the other hand, represents a system of governance that ensures citizens' participation, rights and freedoms. Additionally, social capital encompasses the networks, norms and trust that exist within a community, fostering cooperation, civic engagement and collective action. In this section, we delve into the association between energy use and democracy, followed by an exploration of the relationship between energy use and social capital. Each section critically examines the multidimensional aspects, interactions and potential consequences of these connections.

### 3.1 Democracy and energy use

The level of democracy in a country can have significant implications for energy use, as it influences various variables that shape energy policies and practices. It may vary with the location, culture and preferences of people. Figure 2 shows that a higher democracy level fosters transparency and accountability in governance, enabling the development of effective energy policies, which can then affect the course of energy use patterns (Glass and Newig, 2019).

**Figure 2: Democracy and energy use**



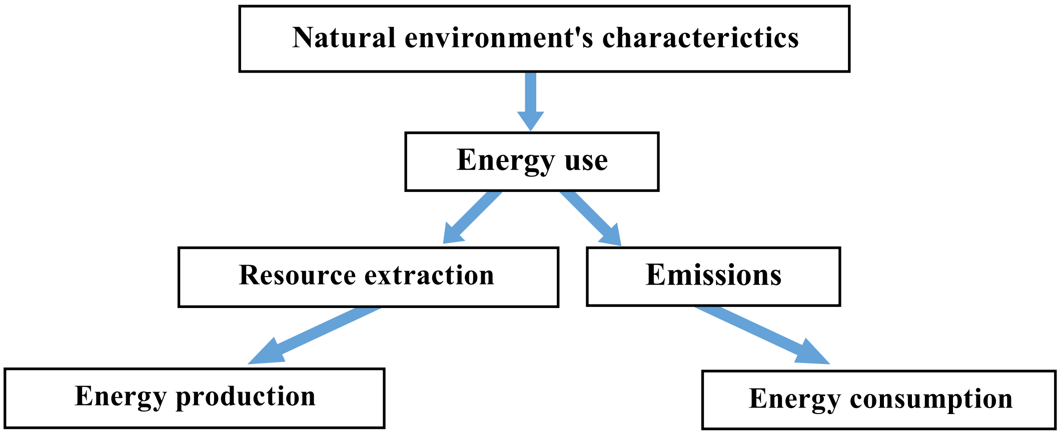

Source: Authors' own elaboration

The second link developed in Figure 2 shows that citizen participation (emerges as a by-product of democracy) plays a vital role in considering sustainable energy options, as democratic processes prioritize the input and concerns of the people (Nouri *et al.*, 2022). Moreover, democratic institutions promote innovation and competition within the energy sector, driving efficiency improvements and encouraging the adoption of renewable energy sources, thus affecting energy use patterns (Chen *et al.*, 2021).

## 3.2 Natural environment and energy use

The natural environment and energy use are strongly intertwined. The literature has established a strong link between energy use, resource accessibility and climate conditions or the natural environment, affecting energy production and then its consumption (Dagar *et al.*, 2022).

**Figure 3: Natural environment and energy use**



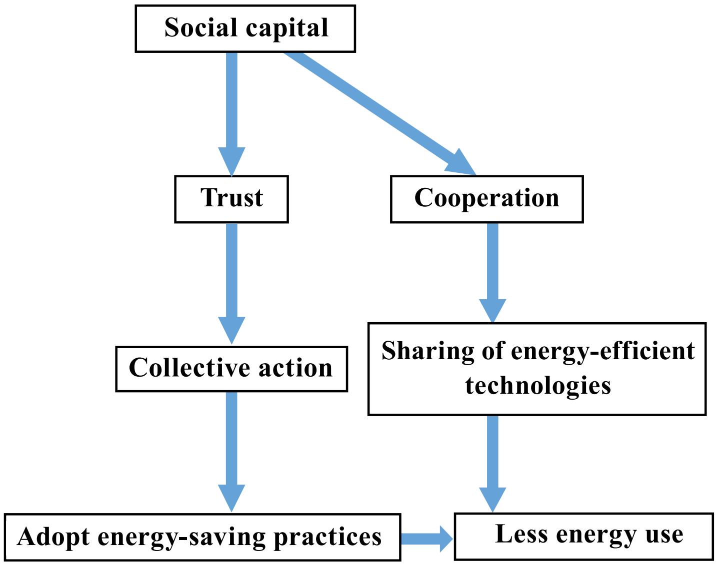

Source: Authors' own elaboration

Figure 3 shows that this dynamic interaction forms a feedback loop, where the characteristics of the natural environment affect energy use, which, in turn, can influence the state of the natural environment through resource extraction and emissions, further shaping energy production and consumption patterns.

## 3.3 Social capital and energy use

Social capital, comprising trust, cooperation and social networks, influences energy use through various channels. Figure 4 forms three important links to explain this relationship. Firstly, trust fosters collective action, encouraging communities to adopt energy-saving practices (Kalkbrenner and Roosen, 2016). Secondly, cooperation facilitates the sharing of energy-efficient technologies and knowledge (Ahmed *et al*., 2015). Thirdly, strong social networks encourage energy-saving behaviour, leading to increased adoption and reduced energy use (Mankoff *et al*., 2010).

**Figure 4: Social capital and energy use**

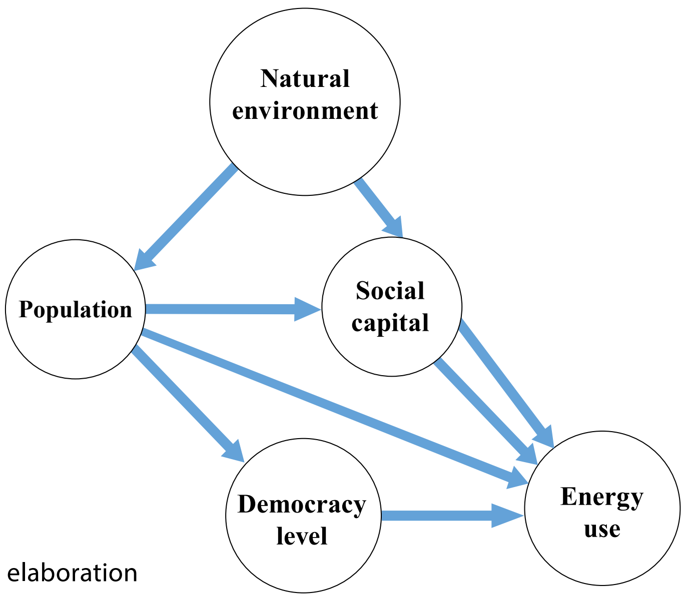



Source: Authors' own elaboration

## 3.4 Composite conceptual framework

Figure 5 presents the crux of the previously elaborated linkages, while adding another important determinant of energy use: population (Avtar *et al.*, 2019). One strain of literature believes that population growth can affect social capital by straining resources, leading to potential conflicts and reduced trust (Colletta and Cullen, 2000).

**Figure 5: Composite conceptual framework**




Source: Authors' own elaboration

Social capital, in turn, influences democracy levels, as higher social capital fosters citizen engagement and participation (Breuskin, 2012). Figure 5 is built on the fact that democracy levels affect energy use through policy-making and regulation (Szulecki and Overland, 2020). Literature provides evidence that a more democratic society is likely to prioritize sustainable energy practices. It is also important to elaborate that the natural environment is affected by energy use (Li and Umair, 2023), highlighting the importance of balancing population growth, democracy and social capital to ensure sustainable energy consumption and environmental conservation.

## 4. Theoretical Framework and Methodology

The theory of ecological modernization proposes that societies can achieve environmental sustainability by integrating technological innovation, policy reforms and institutional changes such as a more democratic society with greater public participation, within a market-based economy (Gibbs, 2000). While this theory is primarily conceptual, we can provide a simplified mathematical representation to illustrate the link between energy use and the environment. Let us consider the following equation:

$$\textit{Energy Use} = \xi + \alpha \times (\textit{Population}) + \beta \times (\textit{GDP per capita}) + \textit{error} \tag{1}$$

In Equation (1), energy use is determined by two main factors: *Population* and *GDP per capita* (a measure of economic development). The coefficients $\alpha$ and $\beta$ represent the respective weights or influence of each factor on energy use.

Population growth directly correlates with increased energy use due to the higher number of individuals requiring energy for various purposes (Catton, 1982). The relationship can be expressed as:

$$E = kP \tag{2}$$

In Equation (2) above, $E$ represents energy use, $P$ represents population and $k$ denotes energy consumption per capita. As population increases, the total energy demand ($E$) rises proportionally, assuming a constant energy consumption per person ($k$). It is important to note here that developed countries having higher GDP per capita are more industrialized and therefore have higher energy use (refer to Equation 1). To mimic this effect, we substitute GDP per capita with the lagged value of energy use in Equation (4). Now, look at Equation (3) below:

$$\textit{Natural Environment} = \xi + \delta \times (\textit{Energy Use}) + \varepsilon \times (\textit{Environmental Regulations}) + \textit{error} \tag{3}$$

The environmental impact is influenced by energy use and the level of environmental regulations set by institutions (Kazim, 2007). To measure institutions, we assume based on earlier literature that democratic societies have better environmental regulations because of their better institutional structures. Democracy level is determined by citizen participation and institutional effectiveness (Armony, 2004). The coefficient $\delta$ represents the impact of energy use on the environment, while $\varepsilon$ reflects the effect of environmental regulations in mitigating that impact. As discussed earlier, energy use forms a feedback loop and can be affected by the natural environment too. Equation (1) thus becomes Equation (4) below.

$$\textit{Energy Use} = \xi + \alpha \times (\textit{Population}) + \beta \times (\textit{lagged energy use}) + \delta \times (\textit{natural environment}) + \varepsilon \times (\textit{democracy levels}) + \textit{error} \tag{4}$$

Adding to the above, social capital is a crucial element in energy use dynamics. It is influenced by trust and civic engagement within a society (refer to Equation 5). The coefficients $\eta$ and $\lambda$ in Equation (5) represent the relative importance of trust and civic engagement in shaping social capital.

$$\textit{Social Capital} = \eta \times (\textit{Trust}) + \lambda \times (\textit{Civic Engagement}) \tag{5}$$

Now, we incorporate social capital along with democracy level into the energy use equation:

$$\textit{Energy Use} = \xi + \alpha \times (\textit{Population}) + \beta \times (\textit{lagged energy use}) + \delta \times (\textit{natural environment}) + \varepsilon \times (\textit{democracy levels}) + \zeta \times (\textit{Democracy Level}) + \textit{error} \tag{6}$$

The coefficients $\zeta$ represent the influence of social capital on energy use. The rationale behind incorporating social capital and democracy level is as follows: higher social capital, characterized by trust and civic engagement, can lead to collective action, cooperation and shared responsibility towards sustainable energy practices. By considering social capital and democracy level alongside with other variables, we can better understand the complex dynamics and interrelationships that shape energy use patterns and their environmental implications.

In order to estimate final Equation (6), it is crucial to address the issue of endogeneity, which can have theoretical implications, especially when an important variable such as institutional quality, specifically democracy, is included in the final model (Aslam, 2020; Aslam *et al.*, 2021; Ghouse *et al.*, 2022). Consequently, the most suitable technique to employ is the generalized method of moments (GMM).

The data used in this analysis were extracted from the Legatum Prosperity Index 2022. The variables considered include democracy level, social capital, natural environment, energy use and population. The sample includes 61 countries spanning the years 2008–2021. The sample consists of 779 observations in total, with a minimum of 12 observations per group. The countries are categorized into regions, namely Asia-Pacific (Bangladesh, India, Indonesia, Japan, Malaysia, Philippines, Republic of Korea, Singapore, Thailand), Eastern Europe (Albania, Estonia, Hungary, Latvia, Poland, Romania, Russia, Serbia, Ukraine), Latin America (Argentina, Bolivia, Brazil, Chile, Colombia, Haiti, Mexico, Panama, Uruguay), Middle East & North Africa (Algeria, Egypt, Israel, Jordan, Kuwait, Oman, Qatar, Saudi Arabia, Sudan), Sub-Saharan Africa (Djibouti, Ethiopia, Ghana, Kenya, Nigeria, Senegal, South Africa, South Sudan, Uganda, Zambia) and Western Europe (Austria, Belgium, France, Germany, Luxembourg, the Netherlands, Norway, Switzerland, the United Kingdom).

## 5. Results

The results of Model 2 (refer to Table 1) indicate that the relationships observed in Model 1, including the signs and significance levels, remain consistent when additional variables are included. This finding enhances the reliability of the results obtained in Model 1, estimated through Equation (6). When the relationships hold true in a non-nested model, it suggests that the observed associations are robust and not solely dependent on specific variable configurations. By including all the variables from Model 2 in Model 1, we conclude that the relationships between energy use and the lagged energy use, population, natural environment and democracy level persist and remain statistically significant. This consistency in significance and signs of Model 1 and Model 2 strengthens the validity of the findings and reinforces the notion that these variables have meaningful impacts on energy use.

Model 1 and Model 2 also show that the variable "democracy level" demonstrates a significant negative relationship with energy use. This suggests that countries with higher levels of democracy tend to have lower energy consumption. One possible explanation is that democratic societies often prioritize sustainability and environmental consciousness, leading to more efficient energy use, renewable energy adoption and policy measures aimed at reducing energy consumption. A similar argument has been given in studies by Adams and Acheampong (2019); Droubi *et al*. (2022); Szulecki and Overland (2020).

**Table 1: Regression results**

| Dependent variable: | (Model 1) | (Model 2) |
|---|---|---|
| **Energy use** | **Final nested model** | **Non-nested model** |
| **Lag (*Energy use*)** | 0.874***<br>(0.0848) | 0.858***<br>(0.0817) |
| ***Population*** | 7.80e-08***<br>(2.68e-08) | 5.40e-08***<br>(1.97e-08) |
| ***Natural environment*** | 1.614**<br>(0.625) | 1.275**<br>(0.558) |
| ***Democracy level*** | −2.595***<br>(0.976) | −2.535***<br>(0.948) |
| ***Social capital*** | −0.300<br>(0.219) | – |
| ***Constant*** | −59.06**<br>(24.90) | −53.75**<br>(23.93) |
| **Observations** | 779 | 779 |
| **Number of countries** | 60 | 60 |
| **AR1** | 0.0001 | 0.0000 |
| **AR2** | 0.93 | 0.603 |

Notes: Sargan test (Model 1): 0.127, Sargan test (Model 2): 0.12; standard errors are in parentheses and ***, **, *, denote statistical significance at the 1%, 5 %, 10% levels, respectively.

Source: Authors' own calculations

In Model 1, the variable "lag (energy use)" shows a significant positive relationship with energy use. This implies that an increase in the lagged energy use is associated with higher energy use in the current period. One possible reason for this is that energy consumption patterns tend to persist over time due to factors such as infrastructure, habits and technology. As energy use increases in previous periods, it is likely to have a carryover effect on energy use in the current period. The results match those of Kouton (2019). The variable "population" also exhibits a statistically significant positive relationship with energy use. This suggests that as the population grows, energy consumption tends to increase as well. This relationship can be explained by the fact that a larger population requires more energy to meet its needs for transportation, housing, industry and other activities. The results are consistent with those of Mohsin *et al*. (2019) and Khan *et al*. (2021).

The variable "natural environment" shows a significant positive relationship with energy use. This implies that regions with a more favourable natural environment, such as abundant natural resources or favourable climate conditions, tend to have higher energy consumption. This could be attributed to the utilization of natural resources for energy production or the higher energy demands associated with certain climatic conditions. The results are in line with those of Dagar *et al*. (2022). The variable "social capital" does not appear to have a significant relationship with energy use in Model 1. Therefore, its impact on energy consumption in this particular model is not evident. Although this variable was of our main interest, its insignificant impact on global data shows that there could be huge differences across the region in terms of social inclusion. Lastly, the Sargan test results for Model 1 and Model 2 are 0.127 and 0.12, respectively. The Sargan test is used in the context of generalized method of moments (GMM) dynamic estimation (two-step) to assess the validity of the over-identifying restrictions in a model, which is valid in both models presented in Table 1.

## 6. Conclusion and Policy Implications

We showed that a country's democracy level has significant impact on energy use, using the generalized method of moments (GMM) method as the econometric settings of the model to cater for any possible effects due to endogeneity. Using data from Legatum Prosperity Index 2022, the results for the social capital variable within this particular model, unlike the literature, do not allow us to identify any significant impacts on energy use. One possible explanation is the use of global data from six regions (Asia-Pacific, Eastern Europe, Latin America, Middle East & North Africa, Sub-Saharan Africa and Western Europe. Each region contains a minimum of 12 observations per group, comprising 61 countries.

The contribution of this paper is the exploration of a reverse linkage of the natural environment on energy use, rather than otherwise, suggesting a positive significant relation. Such a relationship has rarely been explored. Lastly, we also revealed significant positive associations between energy use and lagged energy use, population as well as the natural environment. Conversely, democracy level exhibited a notable negative relationship. We highlight that fostering democratic systems that prioritize sustainability and environmental consciousness may prove instrumental in promoting more efficient energy utilization. Nevertheless, the non-significant impact of social capital suggests the need for alternative approaches to address social factors that influence energy consumption.

## 7. Limitations of the Study

The present study, while providing valuable insights, also highlights several areas for future research and limitations. Firstly, the relationship between democracy and energy use might differ depending on the development stage. Developed democracies, having already undergone a period of high energy consumption, can prioritize energy efficiency and environmental protection as economic priorities shift. To establish causal relationships, future studies could employ longitudinal data to capture temporal dynamics and better address other possible econometric concerns. Since the data availability was limited, we could not extend the analysis after 2021 or before 2018. The sample set may be enlarged upon the availability of data. Broadening the geographical coverage beyond the selected regions of 61 countries would enhance the generalizability of the results. We tried to maximize the balance of countries in each region for a more composite result. Our reliance on data from the Legatum Prosperity Index presents opportunities for future research to explore alternative datasets or sources to validate and extend the findings.

Secondly, expanding the range of variables considered would enhance our understanding of the complex factors influencing energy use. Factors such as other economic indicators, technological innovations and infrastructure development should be included to provide a more comprehensive analysis. We focused primarily on democracy level and social capital as the two main variables as per the objectives. Other institutional variables may also be the subject of analysis in future research. Thirdly, future research could delve into the potential interactions and nonlinear relationships among the variables to gain deeper insights into their complex interplay. Alternative methodologies or statistical techniques beyond GMM could be explored to address endogeneity concerns more effectively and assess the robustness of the findings. Addressing these areas in future research may contribute to a more comprehensive understanding of the factors shaping energy use and pave the way for policy recommendations in the field.

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