Social Media and Energy justice: A Global Evidence

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Abstract

Over the past decades, several advances have been made in the climate field because of human activities, economic situation, and shift in the recognition that the people suffer most from the adverse effects of climate change. According to COP27, it is now commonly acknowledged that the poorest countries—those that pollute the least—are those that experience the worst effects of climate change. This recognition raises the issue of justice in environmental matters: today we speak of environmental justice, which would consist of applying justice principles to energy policy, energy production and systems, energy consumption, and climate change. The objective of this study is to examine the cross-sectional impact of social media penetration, particularly Facebook, on energy justice in a panel of 70 countries. We build three sub-indicators of energy justice: distributive justice, procedural justice, and restorative justice. We use OLS, Oster (2019), Lewbel 2SLS (2012) and Kiviet (2020) instrumental variable techniques and the results show that Facebook penetration improves energy justice across countries. Precisely, Facebook penetration boosts distributive, procedural and restorative justice. Therefore, social media should be included to enhance low-carbon transitions awareness among the masses. Further, social media should be promoted to emphasize on social services equitability, climate-vulnerable economies to help civil awareness and energy resilience.

Keywords

social media; energy justice; panel data.

JEL Codes: D91; E71; O13; C23; C33

1. Introduction

Over the last three decades, greenhouse gases (GHGs), mainly carbon dioxide emissions (CO2 emissions), have accumulated in the atmosphere, leading to environmental degradation and unprecedented global warming (Lashof and Ahuja, 1990; Solomon et *al*., 2009; Liu et *al.*, 2020; Wang et al., 2022; Ayllon et al., 2023). Moreover, climate change is also a burning issue affecting social welfare, stability, security, and economic structure (Schmidhuber and Tubiello, 2007; Spencer and Strobl, 2020; Ren et al., 2021). Environmental degradation is a major issue across most countries because of its harmful effect on health and the nature of economic growth. Environmental degradation is predominantly occurred because of releasing more CO2 emissions. In the name of development, most developed countries precede industrialization and emit more intensive pollution. This sequence of climate events is having catastrophic effects on economies and natural ecosystems (IPCC, 2021). Therefore, IPCC (2022) targets global temperature at industries level below 2 ^{0}C to achieve net zero emissions and carbon neutrality in the near future. Indeed, controlling excessive fossil fuel energy consumption is essential (COP27). Therefore, based on dependence on fossil fuels, society needs to focus on energy justice. It requires efficient government organizations to ensure adequate energy services and redistribute job benefits with risk sharing. In this context, society focuses on energy justice to enhance the low-carbon economy.

According to international disaster data (EM-DAT), between 1900 and 2020, no fewer than 12,386 climate-related disasters have been recorded. These disasters include floods, storms, droughts, forest fires, landslides, and other extreme weather conditions. Regarding human and economic costs, it is estimated that 20 million people will die due to climate-related disasters and that at least US$ 4.13 trillion will be lost in direct economic costs. A recent report suggests a new reality, namely that the countries that suffer the most from climate change's effects are those that pollute the least, i.e., the developing countries.

At the same vein, several developing countries have paid a heavy price for global warming. In Somalia and Kenya, record drought and extreme famine (more than 1.5 million children facing malnutrition) have been recorded. In Madagascar, devastating cyclones have wiped out entire villages, leading to massive displacement. In Pakistan, devastating innovations have caused more than 1,600 deaths, with damage estimated at 30 billion euros. Keeping these in mind, developing countries are demanding justice, an idea supported by António Guterres, the UN Secretary General in these terms: "*Humanity has a choice: cooperate or perish. It is either a climate solidarity pact or a collective suicide pact*"[1]. This needs for developing countries to demand reparations from poor countries raises a new issue like environmental justice, which would involve applying principles of justice to energy policy, energy production and systems, energy use and climate change (Jenkins et al., 2016).

Recently, energy justice has played an important role in energy economics. It has been discussed since Aristotle and philosophers like Adam Smith, Karl Marx, and John Rawls. Moreover, a contemporary discussion between social-economic and local groups has emerged on environmental and climate justice since 1970. It is because of environmental burdens (Schlosberg, 2007; Walker, 2009; McCauley, 2013; Wang et al., 2022; Ayllon et al., 2023). According to UNDP (2000, 2004), energy provisions and sustainable development are important aspects that focus on inequality in income distribution, energy usage, and resource access between developed and developing countries. Indeed, Johansson et al., (2012) found that smart energy systems and small-scale electricity decentralization are the main

[1] This was said by the UN Secretary General at the start of COP27 in Sharm el-Sheikh before nearly 100 heads of state and government.

components to alleviate global poverty and unequal income distributions. Moreover, the accessibility and sustainability of energy systems have been increasing globally due to the higher safety growth of digitalization across countries (IEA, 2017). Global digitalization investment has been about 20% annually since 2014, primarily on infrastructure, digital electricity, and software upgradation. It increases to 0.96 trillion US$ in 2017 and 1.85 trillion US$ in 2022 worldwide. It is expected to be 3.4 trillion US$ in 2026, respectively[2]. It has happened because of job creation, competitiveness, and regional development. According to Enciso-Santocildes et al., (2021), digitalization or social media could be an essential platform to alleviate poverty, resource scarcity, and inequalities. However, the rapid adoption of social media or additions toward social media has also exacerbated inequalities. Furthermore, according to McCauley and Heffron (2018), energy justice has been segregated into distributional justice, procedural justice, and restorative justice, which summarizes its cause, process, and influence.

Indeed, this study examines the effect of social media, mainly the penetration of Facebook, on energy justice. In doing so, this research combines two crucial strands of contemporary energy economics literature. The first strand is the emerging literature on the determinants of energy justice (Wang et al., 2022; Ayllon et al., 2023). The second strand is the extensive literature on the environmental effects of information and communication technology development (Ciplet, 2021). To our knowledge, we are not getting any studies examining the link between Facebook penetration and energy justice. The main novelty of our research has been folded into the following points. First, we evaluate the role of social media (i.e., Facebook penetration) on energy justice in 70 countries. Second, we build three sub-indicators of energy justice: distributive justice, procedural justice, and restorative justice.

[2] https://www.statista.com/statistics/870924/worldwide-digital-transformation-market-size/

Finally, we also use the latest novel econometric technique like Oster (2019), Lewbel 2SLS (2012), and Kiviet (2020) to examine the relationship between the series across countries. Oster (2019) suggests procedures to check for robustness to omitted variable bias. The 2SLS method of Lewbel (2012) is essential for identifying structural parameters in regression models with endogenous. Further, to find the difficulty of a perfectly exogenous social media instrument, we adopt an alternative estimation method, a new methodology recently developed by Kiviet (2020). This is known as the internal instrumental variables method, the no-instrument method, or simply Kinky Least Square (KLS). The results derived from empirical analysis describe that Facebook penetration improves energy justice across countries. Facebook penetration boosts distributive and procedural justice while having a positive but non-significant effect on restorative justice. Therefore, social media should be used as a medium of mechanism while making policies related to energy justice and future energy. Social media should be used in such a way that enhances low-carbon transitions awareness among the masses, social services equitability, and climate-vulnerable economies. It is a platform to get updated across all activities that grids to facilitate access to green energy, and energy resilience. Finally, the policy makes should look at the digital platform and digital infrastructure for making any policies related to energy justice.

The research paper is organized in the following sections. Section 2 describes the literature review. Section 3 explains the data and methodology. Section 4 reveals the empirical results and finally conclusion, policy implications and future research directions in section 5 respectively.

2. Literature review

2.1. *Energy justice and its determinant*

A couple of studies have been conducted related to energy economics. According to Miler et al., (2016) and Sovacool et al. (2016), change in energy systems is the most comprehensive approach to understanding conflicting moral and social values that enhance fair cost and benefit distributions and equitable energy access. A couple of papers explicitly used energy justice with energy policy (Heffron et al., 2015), energy communities (Johnson et al., 2014; Forman, 2017), energy use (Hall, 2013), energy poverty (Bouzarovski and Simcock, 2017; Gillard et al., 2017), and energy supply (Cowell et al., 2011; Wolsink, 2013; Heffron and McCauley, 2017).

Furthermore, it has also been widely implemented in the context of low-carbon energy transitions and climate change (Healy and Barry, 2017; Murshed, 2020; Wang et al., 2022a, 2022b), fossil fuels pollution and nuclear waste (Taebi and Kadak, 2010; Sovacool et al., 2017). Heffron et al. (2015) developed decision-making tools in energy justice that enhance energy policy harmony. Healy and Barry (2017) found that energy justice as the guiding component in energy transitions requires attention to the divestment of fossil fuels. Heffron and McCauley (2014) argued that growth and supply chain might be promoted through energy justice. According to Johnson et al., (2014) and Hall (2013), organizational structure and new community businesses would be the better models for civil society and energy justice for ethical consumption. In the same vein, Taebi and Kadak (2010) argued that the fuel cycle for nuclear power alternatively could be the assessment for intergenerational equity. Finally, Bouzarovski and Simcock (2017) revealed that energy poverty and justice could be highlighted to synchronize inequalities to vulnerabilities. McCauley and Heffron (2018) developed an analytical framework for energy justice that gives policy insight into climate, energy, and environmental scholarship justice transitions. Based on this analytical framework, (Scheuerman, 2018; McCauley et al., 2019; Lacey-Barnacle, 2020; Kalt, 2021; Zhu and Lo, 2021; Coggins et al., 2021; Diduck et al., 2021; Bastos and Mairon, 2022; Vatalis et al., 2022;

and McCauley et al., 2022) analyzed the fossil fuels energy dependence in the realization process of energy transitions.

2.2. Social media and Energy justice

In the same vein, a couple of studies on social media influences on economic growth are investigated (Bulturbayevich et al., 2020), welfare (Grigorescu et al., 2021), and international trade (Ahmedov, 2020). However, whether all three aspects of just transition are justified by social media remains to be determined. The role of social media is more conducive to equitable energy distribution. It can help government organizations locate the locations of energy facilities to meet most people's interests (Gasparovic and Gasparovic, 2019; Chen et al., 2022). In the same vein, it also makes awareness about innovation devices, low energy efficiency, and fossil fuels movement globally (Agostino et al., 2021; Ramzan et al., 2022; Huang et al., 2022).

3. Data and methodology

3.1. Data

Using average data from a panel of 70 industrialized and developing nations, this research examines the link between social media and energy justice. Data availability, particularly data used to construct the energy justice indicators, and data on social media constrained the selection of the study period and the sample countries.

3.1.1. Dependent variable: Energy justice

One of the main difficulties in conducting an empirical study on the determinants of energy justice lies in constructing a quantitative indicator of energy justice. Notably, to date, the measurement of energy justice has no uniform standard and includes multiple types of sub-indicators. Therefore, this study builds on the work of Wang et al., (2022) and applies the improved entropy method (IEM)[3] to construct and design a comprehensive index to measure energy justice. The composite energy justice index comprises three categories and 21 sub-indicators (see Table 1). In the following, we will describe the construction of energy justice. The construction of our main dependent variable, namely energy justice, is based on the work proposed by McCauley and Heffron, (2018). They consider the multidimensional nature of just transition by highlighting three main components: distributive justice, procedural justice, and restorative justice. Although the concept of energy justice has been extensively discussed in the literature (see Jenkins et al. (2016) for a conceptual analysis), its econometric application is still in its infancy (Wang et al., 2022).

- **Distributive justice**: According to Jenkins et al., (2016), distributive justice is the first step in establishing energy justice. For them, it is essential to know who is affected and which communities or regions are affected by injustices. For McCauley et al., (2022), distributive justice refers to the degree of equity within a given community or region. It focuses primarily on the transient equality gaps between economies concerning energy resources, climate change awareness, and social conditions. Drawing on the work of McCauley et al., (2022), we measure distributive justice in

[3] As recalled above, the construction of the energy justice index requires the consideration of 21 sub-indicators, initially divided into three sub-categories (distributive, procedural and restorative justice). To do so, we adopt the improved entropy method (see He et al., 2018 for more details). Overall, the construction of our energy justice index can be summarised in four main steps. However, given the diversity of measurement units of our different sub-indicators, the prerequisite would be a standardisation of our data: $x'_{i,j} = \frac{x_{i,j} - min(x_{i,j})}{\max(x_{i,j}) - \min(x_{i,j})}$ Were $x_{i,j}$ represents the value of sub-index j in country i and $x'_{i,j}$ its normalised value. Once our data is normalized, we proceed through these four steps:

Step 1: We construct the normalized matrix obtained by calculating the ratio between the values of sub-index j of country i and the value of sub-index j of all countries as follows:

$$r_{i,j} = \frac{x'_{i,j}}{\sum_{i=1}^{n} x'_{i,j}}$$

Step 2: we compute the entropy value of sub-index j:

$$e_j = -\frac{1}{\ln(n)} \sum_{i=1}^{n} r_{i,j} \times \ln\left(r_{i,j}\right) \quad ; with\ e_j \geq 0$$

Step 3: We then calculate the weight vector of each sub-index j:

$$W_j = \frac{1 - e_j}{\sum_{j=1}^{m}(1 - e_j)}$$

Step 4: Finally, the overall energy justice index is calculated as follows:

$$ENJUST_i = \sum_{j=1}^{m} W_j \times r_{i,j}$$

terms of six sub-components, namely: (i) fossil fuel dependence; (ii) financial dependence on fossil fuels; (iii) social inequality; (iv) vulnerability to climate change; (v) climate change risks; and (vi) fuel poverty.

- **Procedural justice**[4]**:** Once the individuals affected by injustice are identified, it is crucial to address the question of how. How do we make this transition just while ensuring that all stakeholders participate in achieving a consensual de-carbonization process (McLaren, 2012)? We construct the procedural justice indicator from three sub-components (see McCauley et al., 2022; Wang et al., 2022), namely: (i) the transition process (which takes into institutional account components); (ii) climate change adaptation and mitigation, and (iii) energy efficiency.
- **Restorative justice**: Once the people affected by the injustice have been identified and all stakeholders have consensually agreed on de-carbonization, the next step is to repair the injustice (Moore, 2013). It has been shown that the transition process to a zero-carbon economy will only happen by destroying many jobs. However, the prospect of this job loss could be a significant obstacle to the energy transition process. Consequently, justice will be restorative if it considers the impact of the people concerned in this transition process, which is intended to be fair. We construct the restorative justice indicator from three sub-components, namely: (i) fair employment, (ii) green jobs, and (iii) renewable energy production per capita (see McCauley et al., 2022; Wang et al., 2022).

3.1.2. Key independent variable: social media

Our key variable of interest is social media, measured with Facebook penetration, that is, the share of the population using Facebook for the year 2012. Data on Facebook penetration are

[4]Jenkins et al (2016) highlight another step that should precede procedural justice, namely recognition. For these authors the best way to deal with energetic injustice is to tackle it in this order: (i) identify the concern - distribution, (ii) identify who it affects - recognition, and only then (ii) identify remedial strategies - procedure.

from Quintly, which is a social media benchmarking and analytical solution company[5]. Data on Facebook penetration has been used in recent literature on social media (see for example, Asongu and Odhiambo, 2019). Figure 1 depicts a positive correlation between Facebook penetration and energy justice. In Figure 2, two countries that could potentially be outliers are extracted, namely Iceland and China, and even then, the relationship remains positive. However, as correlation does not mean causation, this relationship will be examined empirically in the next section.

3.1.3. Control variables

The choice of control variables to be introduced into our econometric model was conditioned by at least two factors: on the one hand, the still very embryonic state of the literature on the determinants of energy justice. On the other hand, the large number of variables used (22 in total) in constructing the energy justice index could lead to multi-colinearity, especially endogeneity. Thus, we draw on the only existing empirical study on the determinants of energy justice (Wang et al., 2022) and consider four control variables: (i) gross domestic product per capita, (ii) trade openness as a percentage of GDP, (iii) value added of the industrial sector and finally (iv) continental dummy variables.

Per capita GDP represents one of the significant determinants of energy justice. Indeed, it is empirically demonstrated in the literature that better economic growth is favorable to the development of renewable energies (Ibrahiem and Hanafy, 2021), to the reduction of energy poverty (Barkat et al., 2023; Djeunankan et al., 2023) and to the reduction of gender inequalities. All these factors are, in turn, determinants of energy justice. Therefore, to capture the general macroeconomic condition of an economy, we include per capita GDP (constant US, 2015) as a control variable, and we expect a sign of income per capita. Trade openness is another crucial determinant of energy justice. Trade openness measures the share of imports

[5] The data was accessed from its website (http://www.quintly.com/facebook-countrystatistics?period=1year).

and exports as a percentage of GDP. Increased imports and exports can support the creation of new employment opportunities; contribute to the acquisition of clean technologies and knowledge that support the expansion of renewable energy capacity (Ankrah and Lin, 2020; Lu et al., 2022), all of which improve energy justice. However, trade openness can adversely affect energy justice, primarily if imports or exports are concentrated in natural resources or energy-intensive products (Zhao et al., 2020). The industrial structure of a country is an important determinant of energy justice. Indeed, the development of the industrial fabric is closely linked to the overconsumption of fossil energy. This excessive energy consumption accentuates the economy's dependence on fossil fuels, hinders the development of renewable energies, and consequently reduces energy justice (Wang et al., 2022c). Therefore, we include industrial value added as a control variable and expect a negative effect on energy justice. Table 2 presents the summary statistics and Table 3 displays the pairwise correlation matrix for baseline model.

3.2. Methodology

Following the recent work of Wang et al. (2022), this study investigates the determinant of energy justice by highlighting the role of social media. For the empirical purpose, formulate the following cross-sectional model in Equation (1):

$$EnJustice_i = \alpha + \beta_1 SMedia_i + \beta_2 X_i + \beta_3 Continent_i + \varepsilon_i \quad (1)$$

Where $EnJustice_i$ is the energy justice index for country i. $SMedia_i$ represents social media measured by the penetration of Facebook from Quintly. β_1 is the main coefficient of interest of this study, and in line with the recent study of Wang et al. (2022), we expected a positive sign on $SMedia_i$ ($\beta_1 > 0$). X is a vector of control variables include in our baseline model (including income (GDP per capita), trade openness, and industrial value added). *Continent* represents continent dummies. ε is the country-specific error term.

To estimate this model, we use the least squares method. Although this estimator is interesting when a number of hypotheses are verified, notably the normality of the error term or the absence of heteroscedasticity, to name but two, it does not provide sufficiently robust results due to endogeneity[6]. There are three possible reasons for endogeneity in our basic model. Firstly, the omitted variable bias can arise from not considering an explanatory variable correlated with the explained variable and the error term. Then measurement errors can occur, especially in some developing countries, due to inaccuracy in measuring the Facebook penetration rate in landlocked regions. Finally, endogeneity can arise due to simultaneity or reverse causality. Reverse causality may exist between social media and energy justice. Indeed, due to the need for some non-governmental and international organizations to draw the attention of polluting countries to the consequences of climate change, and to push them to undertake more climate-friendly policies, social networks such as Facebook will be increasingly used and by conquest would legitimize the need for energy justice towards non-polluting countries but victims of climate change.

In order to ensure that our results are not subject to endogeneity problems, we use the instrumental variables method. However, the challenge of using the instrumental variables method is to find an instrument that is perfectly exogenous[7] and appropriate. For Baum et al., (2012), an instrument will be said to be appropriate if it is significantly correlated with the endogenous variable, if it satisfies the orthogonality condition, and if it is correctly excluded from the model so that its effect on the explained variable is only an indirect effect (Baum et al., 2012). The complexity of these conditions does the search for an exogenous instrument challenging. However, the instrumental variables estimation method of Lewbel (2012) offers

[6] Generally, endogeneity refers to a situation in which one of the explanatory variables is correlated with the error term.
[7] A perfectly exogenous instrument is one that is correlated with the variable being explained only through its relationship with the explanatory variable.

us a better alternative when the search for a purely exogenous instrument seems complicated, as in our case.

The 2SLS method of Lewbel (2012) is essential for identifying structural parameters in regression models with endogenous or poorly measured regressors without traditional identification information. Instruments based on heteroskedasticity are incorporated in the 2SLS method of Lewbel (2012). The residuals from the auxiliary equation are multiplied by each external variable in the mean-centered form to construct the internal instruments. The 2SLS method of Lewbel (2012) avoids the typical exclusion limitations as Lewbel's 2SLS estimates without external instruments are quite similar to those obtained with external instruments (Lewbel, 2012). In the literature, many studies use this estimation technique (Acheampong et al., 2021; Domguia et al., 2022). However, for comparison purposes and especially for robustness, we use an alternative model to the basic model in which we instrument the penetration of Facebook. We take our cue from Lapatians (2019) and use the number of secure servers, i.e., using encryption technology in Internet transactions (per 1 million people), as an instrument for Facebook penetration. We naturally expect that the secure Internet will influence the use and especially the penetration of Facebook.

Insert Table 1

Insert Figure 1

Insert Figure 2

Insert Table 2

Insert Table 3

4. Empirical results

4.1. Benchmark results

The OLS estimates of Equation (1) are displayed in Table 3. Column (1) present a parsimonious specification without the control variables. In line with Figure 1, we find a positive and highly significant coefficient associated with social media (Facebook penetration) with a magnitude suggesting that a 10% increase in Facebook penetration lead to a 2.45% increases in energy justice. This result can be explained by the ability of the social media to reach all three dimensions of energy justice. For example, the Facebook social network can be an effective means to reach a larger segment of the population and therefore facilitate the development and especially the popularisation of renewable energy. In addition, the Facebook social network itself represents a job niche and also promotes the development of jobs in the tech sector, all of which reduce unemployment. Moreover, the Facebook social network can increase procedural justice through its effect on various aspects of governance (Asongu and Odhiambo, 2019). Our result is in line with the recent work of Wang et al., (2022c) who showed that the digitalisation of the economy increases energy justice.

Next, in column (2) the size of the market or the level of income is added as control variable. Introducing this control variable into the regression does not change the positive and statistically significant coefficient associated with Facebook penetration. The results confirm the positive and statistically significant effect of social media on the just transition process. The coefficient associated with GDP is positive and significant, meaning that countries with a higher GDP per capita are generally those with the financial means to implement a just transition. This result is consistent with Wang et al., (2022c), who argue that a thriving economy promotes energy justice by making it easier to allocate resources in a post-carbon future, this finding suggests that a more equitable economic development can be achieved as economies grow. In column (3), we control for trade openness. Once again, the coefficient on social media remains positive and statistically significant at the 1% level. Additionally, the coefficient associated with trade openness is positive and statistically significant at the 1%

level, suggesting that trade openness improves energy justice. This result can be explained by the fact that increased trade between countries can support the creation of new employment opportunities, contribute to the acquisition of clean technologies and knowledge that support the expansion of renewable energy capacity (Lu et al., 2022), and all of these improve energy justice. In column (4) we control for the industrial structure of countries by introducing the industrial value added. The coefficient associated with Facebook penetration remains remarkably positive and statistically significant, confirming our basic hypothesis that social media, especially Facebook, increase energy justice. We establish a negative and significant relationship between energy transition and industry value added, suggesting that industrialisation represents a barrier to the just transition as its development goes hand in hand with excessive consumption of fossil energy, all of which increases energy injustice. Moreover, this relationship can be justified by the close link between the development of the secondary (industrial) sector and the consumption of non-renewable energy. Consequently, this sector maintains economies in a kind of dependence on fossil fuels, increases CO2 emissions (Li and Lin, 2015) and consequently inhibits or delays the development of renewable energies, which is a necessary step towards a zero-carbon transition and consequently a just transition. Finally, in columns (6) we control for the effect of continental dummy variables. The results presents in columns (6) are remarkably similar to those displayed in column (5) confirming the beneficial effect of Facebook penetration on energy justice.

Insert Table 4

4.2. Selection on observables and unobservable (Oster stability test)

Although the main hypothesis that social media measured by Facebook penetration increases energy justice is supported by the OLS estimation, it is possible that this is due to the exclusion of relevant confounders. This issue is particularly related to the possibility of critical confounders being overlooked in the baseline model. The Oster test for coefficient stability is used to address this issue. As a result, the selection bias introduced by including observed confounders in the baseline regression model can be reduced, allowing the detection of unobserved factor selection bias (Oster, 2019). Thus, the variation in model specifications' coefficients and R-Squared values with and without observable controls provides some evidence of the severity of selection bias caused by unobservable variables. Oster (2019) suggests using the following procedures to check for robustness to omitted variable bias.

Assuming that selection on unobserved confounders is proportionate to selection on observable confounders and that the highest value of R-squared is 1, we first present the bias-corrected statistic β^*. Specifically, if the constraint between the estimated Facebook penetration coefficient β and the β^* statistic excludes zero, as Oster (2019) claims, then the baseline estimate is not driven purely by unobserved variables. The results of Table 5 in column (2) show that none of these intervals include zero, suggesting that social media may have at least some causal effect on energy justice. Second, the δ statistic is recommended by Oster (2019). The δ values are computed using the restrictive assumption, that the maximum R-squared =0.945. Furthermore, Oster (2019) claims that the δ >1 statistic provides evidence of robustness to unobserved confounders. As shown in column (4) of Table 5, δ values exceed this conventional threshold of one. Overall, the findings indicate that the estimated effects of Facebook penetration on energy justice are unlikely to be explained by unobserved factors.

Insert Table 5

4.3. Endogeneity (Lewbel 2SLS)

Oster's stability test presented in table 5 confirms that no confounding factor biases the effect of social media on energy justice. However, there is still a risk of reverse causality. One of the most widely used estimation techniques to solve this problem of reverse causality remains the instrumental variables method. However, as mentioned above it is often difficult and challenging to find a good and perfectly exogenous instrument. To overcome this difficulty we use the instrumental variables method proposed by Lewbel (2012) and the results of this exercise are presented in Table 6. Column (1) shows the Lewbel model with an internal instrument. Column (2) shows the Lewbel model with internal and external instruments, i.e. the number of secure servers for the year 2010 (lnsecure10). Finally, column (3) shows the results of Lewbel with an internal instrument and an external instrument, i.e. the number of secure servers for the year 2012 (lnsecure12).

First, we note that the results regarding the quality of the instruments are satisfactory. Regarding the suitability of the instruments, the Kleibergen-Paap (2006) Wald F statistic is used to test the weaknesses of the instruments (Kleibergen and Paap, 2006). The Kleibergen-Paap (2006) Wald F statistic must be at least 10 for weak identification not to be considered a problem, as suggested by the 'rule of thumb' of Staiger and Stock (1997). The statistics presented in Table 6 are greater than 10, showing that there is no weak identification problem. Based on the Hansen p values, we cannot reject the null hypothesis that the instruments are uncorrelated with the error term, which suggests that our IV model is well specified, and there is no evidence against the hypothesis of exogenous instruments. In terms of the results of Table 6, the coefficients associated with Facebook penetration in column (1) is positive and statistically significant at the 1% level, corroborating previous results that Facebook penetration increase energy justice. More specifically, a 10% increase in Facebook penetration is associated with a 1.36% increase in just transition. In columns (2) and (3), when combining internal and external instruments, the coefficient associated with Facebook penetration remains positive and statistically significant at the 1% level.

Insert Table 6

4.4. Robustness analysis

We performed several sensitivity analyses to confirm our previous results. First, we estimate our model by introducing several additional control variables. Second, we use alternative samples. Third, we estimate our baseline model using sub-dimensions of energy justice, and finally, we test the robustness of our results with the use of alternative estimation strategy.

4.4.1. Robustness to additional covariates

As a first robustness test, we estimate our model by introducing several additional control variables representing potential determinants of energy justice. These determinants are geographical (latitude), historical (legal origin), cultural (power distance and individualism), and religious (Catholic and Muslim). The results of the estimations are reported in Table 7. From column (1) to column (4), when we introduce each type of control variable successively, the coefficient associated with Facebook penetration remains positive and statistically significant, meaning that social media improve energy justice. Our results are therefore robust to the inclusion of additional control variables.

Insert Table 7

4.4.2. Robustness to outliers

In this subsection, we examine whether our results are sensitive to outliers. Three operations have been performed for this purpose and the results are displayed in Table 8. In column (1), we calculate standardised residuals and restrict the sample to countries with values below the 1.96 limit. In column (2), we estimate robust regression weights and re-estimate the benchmark model using these weights, following the work of Li (1985). Finally, in column (3) and in line with Figures 1 and 2, we remove China and Iceland from our sample and re-estimate our baseline model. Overall, the estimates presented in Table 8 corroborate our baseline results that Facebook penetration promotes energy justice. Therefore, the relationship between Facebook penetration and energy justice is not influenced by outliers.

Insert Table 8

4.4.3. Robustness to alternative measures of energy justice

In the previous analyses, the energy justice index was considered as the dependent variable. The energy justice index is composed of three sub-indicators, namely distributive justice, procedural justice and restorative justice. In this subsection, we analyse how Facebook's penetration affects these different dimensions of energy justice. The results of these analyses are summarised in Table 9. Consistent with the previous results, we observe that all coefficients associated with the three dimensions of energy justice are positive and statistically significant at conventional thresholds. Our results therefore confirm that Facebook penetration positively affects all three dimensions of energy justice, namely distributive justice (column 1), procedural justice (column 2) and restorative justice (column 3).

Several arguments can be put forward to justify this result. First, Facebook penetration can be an effective means of promoting distributive justice. For Jenkins et al (2016), distributive justice is a decisive step in establishing energy justice. For justice cannot be achieved without first knowing who is affected by injustices. Thus, the penetration of Facebook, which is a component of ICTs, can promote distributive justice by making it possible to detect countries or populations that are dependent on fossil fuels, to identify areas that suffer from energy poverty and that are most exposed to the effects of climate change. Second, Facebook penetration can promote distributive justice through its effect on the quality of institutions, the means of adaptation to climate change and especially through its effect on energy efficiency. There is empirical evidence that ICTs promote democracy (Ali, 2020). Therefore, the use of Facebook can be an effective way of informing voters about the environmental policies of politicians before elections and punishing them if necessary. In addition, the social network Facebook can be widely used by governments to disseminate climate change mitigation and adaptation techniques. Finally, ICT development promotes procedural justice by improving energy efficiency (Zhao et al., 2022). Third, Facebook's penetration has the potential to foster restorative justice through its effect on the development of green and decent jobs and accelerate the production and use of renewable energy (Lee et al., 2022).

Insert Table 9

4.4.4. Alternative instrument - free analysis: Kiviet (2020)

In view of the difficulty of finding an instrument for social media that is perfectly exogenous, we adopt an alternative estimation method, a new methodology recently developed by Kiviet (2020). This method is known as the internal instrumental variables method, or the no-instrument method or simply Kinky Least Square (KLS). Unlike the double least squares technique, which relies exclusively on the instrument, the KLS method does not rely on instrumental variables. However, this method has the advantage of analytically correcting the bias of OLS estimates for the postulated range of endogeneity (correlation between error terms and Facebook penetration). Moreover, in the case where the instruments used are weak, the KLS method produces confidence intervals that are mostly narrower than those of the 2SLS (Kiviet, 2023). The results of this exercise are reported in Table 10. Column (1) presents the effect of Facebook penetration on the energy justice index. In columns (2) to (4), we examine the effect of Facebook penetration on the sub-indicators of energy justice, namely, distributive justice (column 2), procedural justice (column 3) and restorative justice (column 4). Overall, the coefficients associated with Facebook penetration all remain positive and significant. These results confirm previous findings that Facebook penetration promotes energetic justice. Therefore, our results remain robust to the use of an alternative estimation method.

Insert Table 10

5. Conclusion and policy implications

Over the past decades, several advances have been made in the climate field. First, there has been recognition that human activities are the main cause of environmental degradation and, by extension, climate change. Secondly, there has been progress in assessing the economic and human damage of climate change. And finally, there has been a shift in the recognition that the people who suffer most from the adverse effects of climate change are those who reside in the countries that pollute the least, in this case poor countries. This recognition raises the issue of justice in environmental matters: today we speak of environmental justice, which would consist of applying justice principles to energy policy, energy production and systems, energy consumption, and climate change.

The empirical literature on both the effects and determinants of energy justice is still in its infancy and the existing work is mostly conceptual. In order to contribute to this literature, this study analyses for the first time the role of Facebook penetration on energy justice. Furthermore, this paper examines the effect of Facebook penetration on three sub-dimensions of energy justice, namely distributional justice, procedural justice and restorative justice. For empirical purposes, we use the Ordinary Least Squares (OLS) estimation technique, the stability test of Oster (2019), the instrumental variables method of Lewbel (2012) and Kiviet (2020). Although this estimator is interesting, when a number of hypotheses are verified, notably the normality of the error term or the absence of heteroscedasticity. In order to ensure that our results are not subject to endogeneity problems, we use the instrumental variables method. However, the instrumental variables estimation method of Lewbel (2012) offers us a better alternative when the search for a purely exogenous instrument seems complicated, as in our case. We also use the KLS method that does not rely on instrumental variables. However, this method has the advantage of analytically correcting the bias of OLS estimates for the postulated range of endogeneity. Moreover, in the case where the instruments used are weak, the KLS method produces confidence intervals that are mostly narrower than those of the 2SLS (Kiviet, 2023).

Starting from a panel of 70 countries, we obtain the following results. First Facebook penetration improves energy justice across countries. Second, Facebook penetration boosts distributive, procedural, and restorative justice. Thus, the penetration of Facebook, which is a component of ICTs, can promote distributive justice by making it possible to detect countries or populations that are dependent on fossil fuels, to identify areas that suffer from energy poverty, and that are most exposed to the effects of climate change. Moreover, the Facebook social network can increase procedural justice through its effect on various aspects of governance. Our result is in line with the recent work of Wang et al., (2012) and Asongu and Odhiambo (2019), who showed that the digitalisation of the economy increases energy justice. On the other side, indeed, Facebook penetration influences ICT development to promote procedural justice by improving energy efficiency. Our result is also in the line of Zhao et al., (2022). Finally, Facebook's penetration has the potential to foster restorative justice through its effect on the development of green and decent jobs and accelerate the production and use of renewable energy (Lee et al., 2022).

Based on the empirical results, we give the following polices. First, social media (i.e., Facebook penetration) would be the most conducive for the progress process of energy justice globally. Therefore, social media should be included in such a way that enhances low-carbon transitions awareness among the masses. It encourages the unemployed masses in the society to know- how the internet usage for getting reemployed. Second, social media is just a platform to get updated across all activities that grids help to facilitate access to green energy. It should be promoted to emphasize on social services equitability, climate-vulnerable economies to help civil, awareness and energy resilience. Third, the policy makes should look at the digital platform and digital infrastructure for making any policies related to energy justice. Finally, government should organize event, public meeting, camp through digitalization that encourage people to familiar with social media. Our results are aligning with the study of Gasparovic and Gasparovic, (2019) and Chen et al., (2022) who found that the role of social media is more conducive to equitable energy distribution. It can also help government organizations locate the locations of energy facilities to meet most people's interests (Gasparovic and Gasparovic, 2019; Chen et al., 2022). In the same vein, it also makes awareness about innovation devices, low energy efficiency, and fossil fuels movement globally (Agostino et al., 2021; Ramzan et al., 2022; Huang et al., 2022). Future research can be done by taking disaggregate level database or industries level database for unit level policies, local level or industries level across countries. One can make a case study to understand the role of social media on energy justice across provinces of the countries.

Authors' Contribution:

Ming Fang: Final input & editing on the revised draft, conceptualization, writing - original draft**. Henri Njangang**: Data curation, investigation, writing – formal analysis, original draft. **Hemachandra Padhan**: Supervision, final input & editing the original draft, writing –revised draft. **Colette Simo:** Literature review, final input & editing on the revised draft, writing - original draft. **Cheng Yan:** Supervision, final input & editing on the revised draft, conceptualization, writing - original draft.

Declarations:

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Figure 1: Social media and Energy justice (full sample)

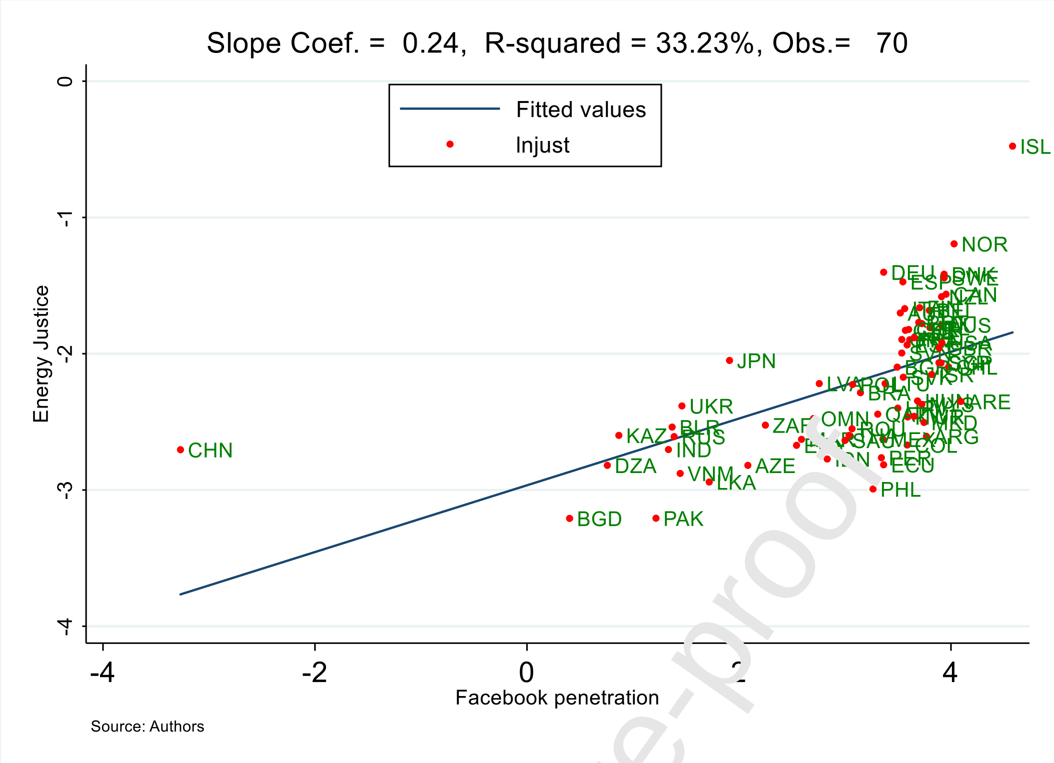

Figure 2: Social media and Energy justice (without China and Iceland)

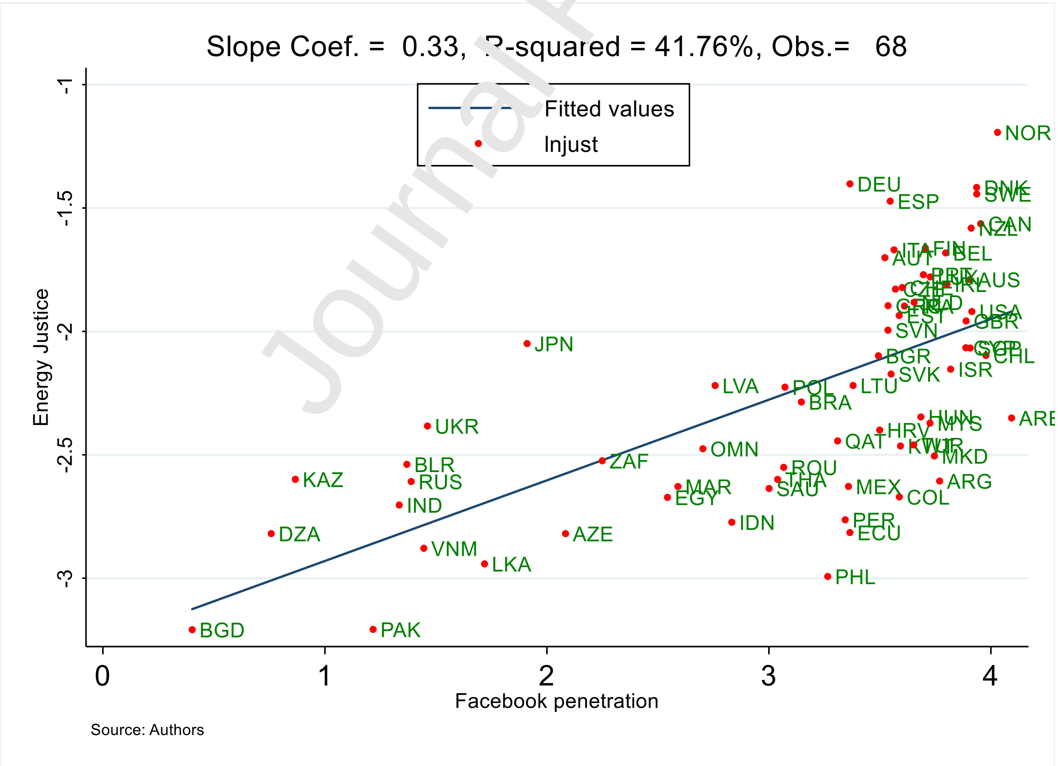

Table 1: the sub-indexes names and data sources of the energy justice index

	Indicators	Descriptions	Units	Sources
Distributional justice	Dependence on fossil energy	Electricity generation from oil Electricity generation from natural gas Electricity generation from coal	GWh GWh GWh	IEA (2022) IEA (2022) IEA (2022)
	financial dependence on fossil fuels	Coal rent (% of GDP) Oil rent (% of GDP) Natural gas rent (% of GDP)	% % %	WDI WDI WDI
	Social inequality	Gender inequality index	-	UNDP (2022)
	Climate change vulnerability	ND-GAIN country index	-	ND-GAIN(2022)
	Climate change risks	Global climate risk index	-	Eckstein et al. (2021)
	Energy poverty	The proportion of the total population with access to electricity	%	WDI
Procedural justice	Transition process	Control of corruption Voice and accountability Rule of law	- - -	WGI WGI WGI
	Climate change adaptation and mitigation	The proportion of the total population with primary reliance on clean fuel and technology	%	WDI
	Energy efficiency	GDP/Primary energy consumption	Billion USD/EJ	WDI
Restorative justice	Fair jobs	Share of labor in GDP, including wages and social protection	%	ILOSTAT (2022)
	Green jobs	Employment in services (% of total employment)	%	WDI
	Renewable energy electricity output per capita	Hydro generation per capita Solar generation per capita Wind generation per capita Geothermal and biomass generation per capita	GWh/million person GWh/million person GWh/million person GWh/million person	IEA (2022) IEA (2022) IEA (2022) IEA (2022)

Sources: McCauley et al. (2022) and Wang et al. (2022).

Table 2: summary statistics

Variables	Definitions	Sources	Obs	Mean	SD	Min	Max
lnEjustice	Energy justice index, Averaged from 2010 to 2019.	Authors construction	70	-2.218	0.514	-3.208	-0.477
lnEjustice1	Distributive justice, Averaged from 2010 to 2019.	Authors construction	70	-0.419	0.243	-1.063	-0.032
lnEjustice2	Procedural justice, Averaged from 2010 to 2019.	Authors construction	70	-0.941	0.398	-1.926	-0.422
lnEjustice3	Restorative justice, Averaged from 2010 to 2019.	Authors construction	70	-3.480	1.034	-5.395	-0.507
Lnfacebook	Facebook penetration (2012), defined as the percentage of total population that uses Facebook	Quintly	70	3.051	1.211	-3.269	4.581
lnsecure10	the number of secure servers for 2010	World Bank	70	7.143	2.182	2.639	13.551
lnsecure12	the number of secure servers for 2012	World Bank	69	5.255	2.234	0.551	8.487
lngdp	Per capita GDP (constant 2010 USD prices), Averaged from 2010 to 2019	World Bank	70	26.301	1.493	22.930	30.461
lntrade	Some of exports and imports (%GDP), Averaged from 2010 to 2019	World Bank	70	4.411	0.552	3.223	5.911
lnind	Industry value added (%GDP), Averaged from 2010 to 2019	World Bank	70	3.335	0.380	2.344	4.315
Africa	Africa dummies	Authors construction	70	0.057	0.234	0.000	1.000
Europe	Europe dummies	Authors construction	70	0.500	0.504	0.000	1.000
Asia	Asia dummies	Authors construction	70	0.286	0.455	0.000	1.000
	North America dummies	Authors	7	0.	0.	0.	1.

Namerica		construction	0	043	204	000	000
Samerica	South America dummies	Authors construction	70	0.086	0.282	0.000	1.000
Legoruk	UK legal origin dummies	Laporta et al. (1997)	70	0.257	0.440	0.000	1.000
Legorfr	French legal origin dummies	Laporta et al. (1997)	70	0.343	0.478	0.000	1.000
Legorso	Social legal origin dummies	Laporta et al. (1997)	70	0.271	0.448	0.000	1.000
Legorge	German legal origin dummies	Laporta et al. (1997)	70	0.057	0.234	0.000	1.000
Legorsc	Scandinavian legal origin dummies	Laporta et al. (1997)	70	0.071	0.259	0.000	1.000
Absolute latitude	This index capture a country's absolute latitude (in 100s)	Portland Physical Geography	70	0.411	0.190	0.014	0.722
Power distance	This index indicates the magnitude of unequal power distribution with higher respect for rank within a national culture	Hofstede Insights (2020)	62	4.010	0.468	2.485	4.654
Individualism	This index capture the preference for a loosely-knit social framework in which individuals are expected to take care of only themselves and their immediate families	Hofstede Insights (2020)	62	3.731	0.554	2.197	4.522
Muslim80	The proportion of Muslim in the population	Laporta et al. (1999)	70	20.265	35.657	0.000	99.400
catholic80	The proportion of Catholics in the population	Laporta et al. (1999)	70	32.571	38.433	0.000	96.900

Table 3: pairwise correlation matrix

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(1) Ejustice	1.000							
(2) Ejustice1	0.738*	1.000						
(3) Ejustice2	0.872*	0.772*	1.000					
(4) Ejustice3	0.929*	0.599*	0.746*	1.000				
(5) Facebook	0.576*	0.441*	0.626*	0.523*	1.000			
(6) GDPP	0.090	-0.120	0.098	0.109	-0.155	1.000		
(7) Trade	0.249	0.492*	0.392*	0.152	0.261	-0.515*	1.000	

(8) Indystry_va	-0.443*	-0.239	-0.370*	-0.487*	-0.280	-0.006	-0.024	1.000

** p<0.1*

Table 4: Baseline OLS

	Dépendent variable : Energy justice				
	(1)	(2)	(3)	(4)	(5)
Facebook penetration	0.2449***	0.2570***	0.2360***	0.1980***	0.1719***
	(0.0746)	(0.0637)	(0.0597)	(0.0597)	(0.0611)
GDP per capita		0.0633*	0.1078**	0.1043**	0.1005**
		(0.0376)	(0.0483)	(0.0472)	(0.0490)
Trade openness			0.2473**	0.2575**	0.1257
			(0.1055)	(0.1026)	(0.1153)
Industry_VA				-0.4104***	-0.1052
				(0.0915)	(0.1021)
Africa					-0.5596***
					(0.1794)
Europe					-0.1695
					(0.1897)
Asia					-0.6218***
					(0.2004)
North America					-0.5052*
					(0.2931)
South America					-0.7086***
					(0.1643)
Constant	-2.9656***	-4.6672***	-6.8654***	-5.3338***	-5.2140***
	(0.2368)	(0.9264)	(1.5490)	(1.6332)	(1.6275)

Observations	70	70	70	70	70
R-squared	0.3323	0.3653	0.4147	0.4993	0.6223

Notes: *, **, *** denote statistical significance at the 10%, 5% and 1% levels respectively. Robust standard errors reported in parenthesis.

Table 5: tests for stability and omitted variables bias

Dependent variables	(1) Controlled effect ($\hat{\beta}$)	(2) Oster bounds ($\hat{\beta}$, β^{*})	(3) $Rmax$ $value$	(4) Delta (δ)
Facebook penetration	0.1719***	[0.1719 , 0.245]	0.945	1.015>1
Baseline controls	Yes	Yes	Yes	Yes
Continent	Yes	Yes	Yes	Yes
Excluded zero		Yes		

Notes: δ is the degree of selection on unobserved variables relative to that on observed variables. β^{*} represents the bias-adjusted coefficient assuming δ = 1.

Table 6: Endogeneity: Lewbel (2012)

	Dependent variable : Energy justice		
	Lewbel with internal IVs	Lewbel with internal and external IVs (2010)	Lewbel with internal and external IVs (2012)
	(1)	(2)	(3)
Facebook penetration	0.1357***	0.1928***	0.1746***
	(0.0486)	(0.0728)	(0.0642)
GDP per capita	0.0991**	0.1018**	0.1006**
	(0.0457)	(0.0461)	(0.0457)
Trade openness	0.1511	0.1181	0.1238
	(0.1013)	(0.1159)	(0.1075)
Industry_VA	-0.1140	-0.1046	-0.1045
	(0.1010)	(0.0933)	(0.0944)
Africa	-0.6308***	-0.5181***	-0.5543***
	(0.1577)	(0.1906)	(0.1787)
Europe	-0.2067	-0.1529	-0.1667
	(0.1680)	(0.1834)	(0.1770)
Asia	-0.6904***	-0.5765***	-0.6168***
	(0.1777)	(0.1974)	(0.1934)
North America	-0.5079*	-0.5041*	-0.5050*
	(0.2722)	(0.2707)	(0.2713)
South America	-0.7171***	-0.7014***	-0.7080***
	(0.1495)	(0.1533)	(0.1526)
Constant	-5.1041***	-5.3030***	-5.2221***
	(1.5629)	(1.5269)	(1.5243)
Observations	70	69	70
R-squared	0.6176	0.6123	0.6223

Hansen	0.243	0.0468	0.143
Kleibergen-Paap rk LM P-value	0.0126	0.0371	0.0212
Kleibergen-Paap rk Wald F	37.81	31.48	45.25

Notes: *, **, *** denote statistical significance at the 10%, 5% and 1% levels respectively. Robust standard errors reported in parenthesis.

Table 7: Additional controls

	Dependent variable : Energy justice			
	(1)	(2)	(3)	(4)
lnfacebook	0.1042***	0.1513***	0.1803***	0.0746**
	(0.0312)	(0.0326)	(0.0551)	(0.0291)
Baseline controls	Yes	Yes	Yes	Yes
Continent	Yes	Yes	Yes	Yes
Legor_uk	-0.7432***			
	(0.1764)			
Legor_fr	-0.6580***			
	(0.1730)			
Legor_so	-0.7849***			
	(0.1813)			
Legor_ge	-0.3425*			
	(0.1771)			
Absolute latitude		1.1921***		
		(0.2096)		
Catho80			-0.0026*	
			(0.0015)	
Muslim80			-0.0031*	
			(0.0017)	
Power distance				-0.2661***
				(0.0617)
Individualism				0.1565***
				(0.0588)
Constant	-3.8279***	-7.1177***	-5.3375***	-5.4924***
	(1.0603)	(0.9641)	(1.3734)	(0.7876)
Observations	70	70	70	62
R-squared	0.7698	0.6937	0.6586	0.7874
Kleibergen-Paap rk LM P-value	0.0143	0.0114	0.0437	0.132
Kleibergen-Paap rk Wald F	59.64	856.0	34.69	49.76

Notes: *, **, *** denote statistical significance at the 10%, 5% and 1% levels respectively. Robust standard errors reported in parenthesis.

Table 8: Excluding potential outliers

	Dependent variable: Energy justice		
	Standardized residuals	Regression weights of Li (1985)	without China and Iceland
	(1)	(2)	(3)
Facebook penetration	0.1690***	0.1306***	0.1802***
	(0.0382)	(0.0359)	(0.0435)
GDP per capita	0.1257***	0.1402***	0.1247***
	(0.0234)	(0.0203)	(0.0236)
Trade openness	0.2123***	0.2190***	0.1759**
	(0.0679)	(0.0652)	(0.0764)
Industry_VA	-0.1634**	-0.1123	-0.0991
	(0.0745)	(0.0764)	(0.0909)
Africa	-0.5424***	-0.6181***	-0.5344***
	(0.1535)	(0.1639)	(0.1646)
Europe	-0.2830*	-0.2799*	-0.2273
	(0.1556)	(0.1665)	(0.1703)
Asia	-0.6599***	-0.7206***	-0.6580***
	(0.1662)	(0.1777)	(0.1758)
North America	-0.5489**	-0.6324**	-0.5509**
	(0.2593)	(0.2470)	(0.2652)
South America	-0.6739***	-0.7041***	-0.6915***
	(0.1520)	(0.1623)	(0.1604)
Constant	-6.0308***	-6.4594***	-6.1102***
	(0.7430)	(0.6849)	(0.7420)
Observations	67	69	68
R-squared	0.7415	0.7455	0.7245
Kleibergen-Paap rk Wald F	212.1	52.91	96.89
Kleibergen-Paap rk LM P-value	0.00301	0.0114	0.00355

Notes: *, **, *** denote statistical significance at the 10%, 5% and 1% levels respectively. Robust standard errors reported in parenthesis.

Table 9: Alternative measures of energy justice

	Distributive justice	Procedural justice	Restorative justice
	(1)	(2)	(3)
Facebook penetration	0.0523**	0.1492***	0.1819*
	(0.0235)	(0.0280)	(0.0945)
GDP per capita	0.0294**	0.1183***	0.2480***
	(0.0150)	(0.0197)	(0.0713)
Trade openness	0.1782***	0.3081***	0.2099
	(0.0505)	(0.0613)	(0.1647)
Industry_VA	-0.0085	-0.0885	-0.2655
	(0.0669)	(0.0800)	(0.1931)
Africa	-0.2864**	-0.3788***	-1.5517***
	(0.1125)	(0.1299)	(0.3151)
Europe	-0.1477**	-0.3452***	-0.4243
	(0.0634)	(0.0960)	(0.3172)
Asia	-0.2761***	-0.5383***	-1.5686***
	(0.0885)	(0.1194)	(0.3365)
North America	-0.2641***	-0.4351***	-1.3245**
	(0.0744)	(0.1599)	(0.5809)
South America	-0.2539***	-0.5891***	-1.1387***
	(0.0918)	(0.1262)	(0.2552)
Constant	-1.9039***	-5.1480***	-9.7347***
	(0.5524)	(0.6706)	(2.3169)
Observations	70	70	70
R-squared	0.4586	0.6945	0.5887
Hansen	0.407	0.208	0.139
Kleibergen-Paap rk LM P-value	0.0126	0.0126	0.0126
Kleibergen-Paap rk Wald F	37.81	37.81	37.81

Notes: *, **, *** denote statistical significance at the 10%, 5% and 1% levels respectively. Robust standard errors reported in parenthesis.

Table 10: Kinky Least Square (KLS)

	Energy justice	Distributive justice	Prodecural justice	Restorative justice
	(1)	(2)	(3)	(4)
Facebook penetration	0.1316***	0.0402*	0.1284***	0.1920**
	(0.0410)	(0.0219)	(0.0279)	(0.0836)
GDP per capita	0.0989***	0.0339*	0.1137***	0.1904***
	(0.0320)	(0.0179)	(0.0221)	(0.0659)
Trade openness	0.1539	0.2005***	0.3102***	0.1401
	(0.0993)	(0.0553)	(0.0684)	(0.2040)
Industry_VA	-0.1150	0.0020	-0.0820	-0.3136
	(0.1267)	(0.0707)	(0.0873)	(0.2603)
Africa	-0.6388**	-0.2811*	-0.4710**	-1.4823**
	(0.2887)	(0.1607)	(0.1987)	(0.5931)
Europe	-0.2109	-0.1621	-0.3520**	-0.3401
	(0.2418)	(0.1348)	(0.1665)	(0.4968)
Asia	-0.6981***	-0.3135**	-0.5872***	-1.5039***
	(0.2571)	(0.1430)	(0.1770)	(0.5282)
North America	-0.5082*	-0.3377**	-0.5514***	-1.3470**
	(0.2954)	(0.1650)	(0.2035)	(0.6072)
South America	-0.7181***	-0.3039**	-0.6096***	-1.1473**
	(0.2615)	(0.1460)	(0.1801)	(0.5374)
Constant	-5.0918***	-2.0973***	-4.9715***	-7.8042***
	(1.1784)	(0.6579)	(0.8118)	(2.4218)
Observations	70	70	70	70
xkurtosis	21.38	21.38	21.38	21.38
grid_min	0.0500	0.0500	0.0500	0.0500
grid_max	0.600	0.600	0.600	0.600
grid_step	0.0100	0.0100	0.0100	0.0100

Notes: *, **, *** denote statistical significance at the 10%, 5% and 1% levels respectively. Robust standard errors reported in parenthesis.

Highlights

- Investigates the impact of social media on energy justice.
- The cross-sectional data are used for the 70 countries.
- Sub-indicators of energy justice: distributive, procedural, and restorative is used.
- Use Oster (2019), Lewbel 2SLS (2012) and Kiviet (2020) techniques.
- Social media improves energy justice across countries.
- Social media boosts distributive, procedural and restorative justices.