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The Roles of Political Risk and Energy Technology Investments

Gender and Energy Transition: How do Political Risk and Regulation Matter?

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Abstract

The energy transition process might face cognitive bankruptcy because of prevailing gender bias in the energy sector. Policy reorientation is needed to ensure diminishing of gender bias in the transition process. The political risk persisting within the economy, as well as among its international counterparts, also needs to be internalized within this framework. Existing regulatory infrastructure might possibly have an impact on shaping the dimensions of this association. The present study aims at analysing the effect of energy transition on gender inequality in the USA in light of political risk and regulations. Moderation effects are captured using marginal impact analysis. The estimation results show that although energy transition increases gender inequality, it is reduced in the presence of moderation. The policy framework developed in the study is aimed at attaining the objectives of Sustainable Development Goals (SDG) 5 and 7.

Keywords: Gender inequality, energy transition, political risk, USA

JEL Classification: J16, Q40, Q42, Q48, P48

1. Introduction

The economic growth pattern of a country depends on the availability of sources of energy, primarily fossil fuels. The use of fossil fuel-based energy leads to emission of carbon dioxide and other greenhouse gases causing climate change. Addressing this issue requires energy transition through expansion in renewable energy production. The flagship report of the IEA

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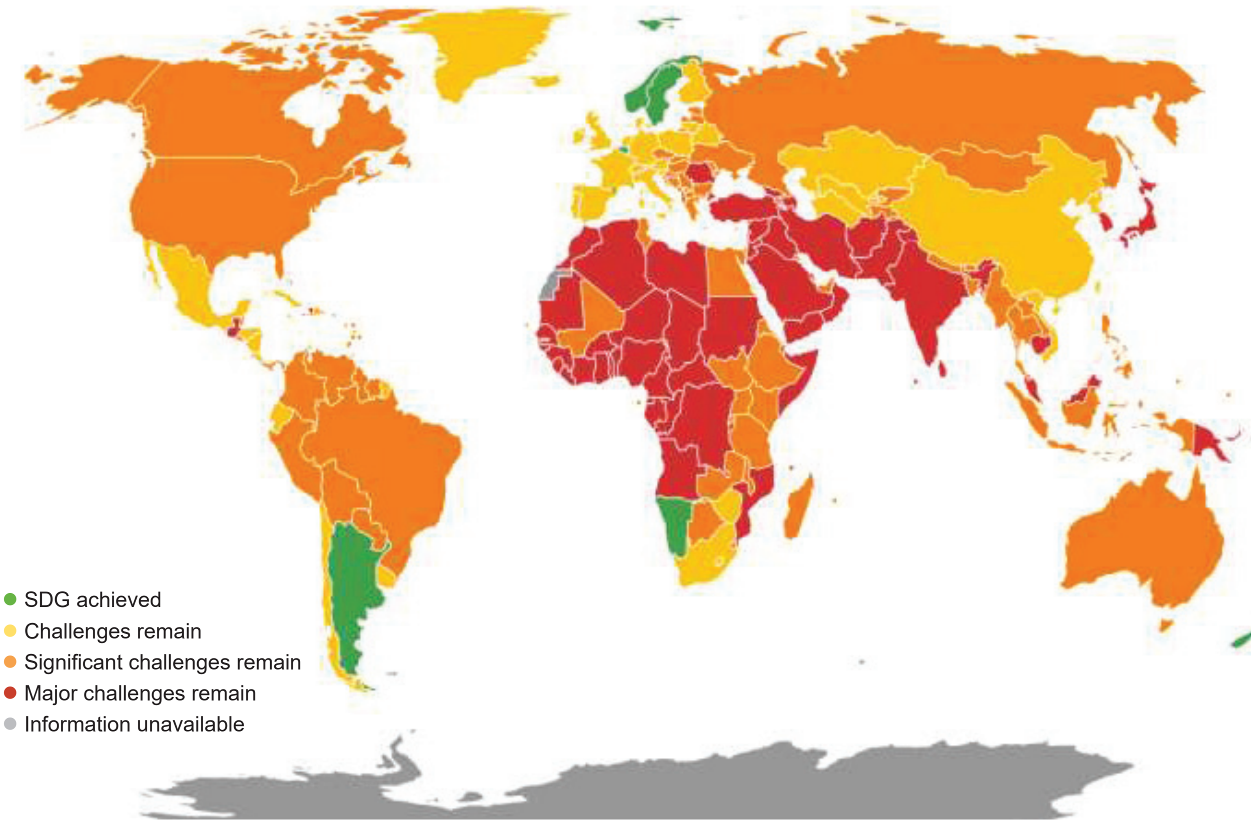
Net Zero by 2050 also discusses the benefits associated with energy transition (Bouckaert *et al*., 2021). Consequently, the production of renewable energy has an annual average increment of almost 17% in 2018 (Dudley, 2018). Nevertheless, energy transition mainly focuses on technological aspects while disregarding its social externalities. The social inequalities are seen as persisting gender blindness at the energy policy level (Mang-Benza, 2021), and this lays the base for the present study.

The underpinning cause of blindness towards gender inequalities hints at the gender bias present in the energy sector. According to the European Parliament's Policy Department for Citizens' Rights and Constitutional Affairs, the energy sector is the most gender-imbalanced sector (Clancy and Feenstra, 2019). Being male-dominated, the gap in employment is twice wider compared to non-energy sectors and there is a 20% difference in wages between female and male employees irrespective of their skill levels (IEA, 2022). Furthermore, less than 5% of women hold top positions in the energy sector and only around 14% of women occupy senior management positions in energy-related firms (Pilgrim *et al*., 2021). A study by the International Renewable Energy Agency (IRENA) states that female representation in government and inter-governmental institutions is alarmingly low (Ferroukhi *et al*., 2019). Globally, women occupy only 6% of minstrel positions related to designing of energy policies (Clancy and Feenstra, 2019). These inequalities persist on both the supply and demand sides. Women become victims of energy poverty, as increased access to energy helps in meeting fundamental necessities such as clean water, efficient lighting, cooking and heating facilities, better healthcare provision, and convenient transport and telecommunication services. Contrary to the findings of Lukeš *et al*. (2013), as women are primarily responsible for care-giving activities at home, they become accountable for gathering firewood or other sources of dirty fuel and may have to travel long distances with heavy loads of different sources of fuel. Performing these activities results in a dearth of time for engaging in education or economic activities (Winther *et al*., 2019). Furthermore, women are susceptible to premature death owing to household air pollution caused by cooking smoke (WHO, 2023). The increased access to clean or modern energy alternatives can be transformative and beneficial for women, which in turn might assist in achieving gender equality, *i.e.*, SDG 5. The *Sustainable Development Goal 2023* progress report by Sachs *et al*. (2023) shows the lacuna of most of the countries in achieving the SDG 5 objectives. The global SDG 5 attainment status is displayed in Figure 1.

The above discussion shows that an economy cannot become sustainable by turning deaf to the need of half of the population. Hence, climate policies must have a gendered approach, as has been put forth by Robinson, a former UN climate envoy: "*Climate change is a man-made problem and must have a feminist solution*" (Mang-Benza, 2021). The absence of women among the decision-making position in the energy sector has resulted in a void on the policy front. There is a need for a gendered perspective because decarbonizing the sources of energy supply "*could* *provide opportunities to develop more socially just ways of living that put the concerns of those most exploited – women, people of color, and the global 99 percent – at the core of energy transition politics*" (Wilson, 2018). Hence, there is a probability of addressing gender inequality through the attainment of cleaner energy sources, and vice versa, *i.e.*, SDG 5 and SDG 7 complement one another. The attainment of one can pave the way for attaining the other.

Figure 1: Global Status of SDG 5 attainment



Source: Author's own elaboration

Considering the importance of women in energy transition for addressing climate change, the Paris Agreement put forth the need for endorsing gender equality in mitigating and supporting gender-responsive adaptation (Zusman *et al*., 2016). Furthermore, the Sustainable Development Goals 2022 report shows that many advanced countries are failing to ensure accessibility to affordable and reliable energy sources for all (UN, 2022). One of the possible reasons behind this failure could be related to limited or non-incorporation of gender dynamics in energy transition. In the USA, women's representation in boards of energy companies is low (Allison *et al*., 2019). A study on Russell 3 000 companies found that approximately 61% of the energy companies with headquarters in the United Stated have no female board member (GMI Ratings, 2012).

Women occupy only 32% of jobs in the clean energy generation sector (Ferroukhi *et al*., 2019). To tackle the gender-imbalance, G7 energy ministers have regarded the global energy transition as an opportunity to encourage diversity in the sector by committing to the *Equal by 30 Campaign* to achieve equal pay, leadership participation and opportunities for women in the energy sector. Despite the efforts made, the gender employment gap in the US energy sector is more than 80%, *i.e.*, the highest among the G7 countries (Hepp *et al*., 2019). The lack of female representation in the energy sector has probably led to failure in the fulfilment of SDG 7 in the USA. The void can have an overwhelming impact on the prevailing gender inequalities, which in turn can become a hurdle in the attainment of SDG 5. Hence, gender mainstreaming in energy transition policies is necessary, and this lays the basis for the present study.

Nevertheless, the transition to renewable energy can affect economic growth (Jahanger *et al*., 2022; Rafei *et al*., 2022). This calls for a revamped role of technological innovation to increase effectiveness of renewable energy for accomplishing a nation's pro-growth objective, while addressing gender inequalities (Saha *et al*., 2022). This facilitation requires mitigating political risk to ensure investment in renewable energy sector (Zhang *et al*., 2022). The role of governance can also be crucial for betterment of domestic political climate. This was a part of discussion of the Council on Foreign Relations during the COP26 Summit (Sinha *et al*., 2023). Hence, policies focusing on energy transition must be realigned to tackle gender imbalance in the energy sector. This realignment also needs to mitigate political risk and boost governance. The present study attempts to address this policy void. Hence, the research question of this study is as follows:

> "*How can policy repositioning address the effect of energy transition on gender inequality in the USA under the moderating effect of political risk?*"

Answering this research question will help develop a realigned gender-oriented energy policy framework for the USA while internalizing the external policy factors. This new policy framework will help accomplish the objectives of SDG 5 and 7. There is a void in the academic literature, on which the present study focuses by developing a policy framework that will enable the USA to mainstream gender issues while considering low-carbon energy sources to meet energy demand.

Designing a robust policy framework requires addressing the possible endogeneity issue in the empirical model. Hence, fully modified ordinary least squares (FMOLS) is suitable for the time series specification of the model. Additional understanding of the model is obtained by quantile regression. This method gives the flexibility of analysing the data through various quantiles for dealing with the dynamism of an economy. This empirical exercise can reveal the conduciveness of the policy environment and the policy priorities required for developing the policy framework.

2. Literature Review

The rising emissions at the global level are due to an increase in the release of carbon dioxide and greenhouse gases resulting from the oxidation of fossil fuels. This is in turn resulting in climate change, and the shift needs to be mitigated through energy transition. Energy transition is regarded as a transformation of "*not only the technologies and economics of energy but also physical and social geographies, social meanings, and the political organization of energy production, distribution, and consumption*" (Miller *et al*., 2015). Presently, the transition to sustainable and low-carbon fuel sources is seen as the future and a possible way of addressing issues related to rising emissions, which has been considered under SDG 7. The path of achieving this transition is by expanding use of renewable sources of energy that might be able to provide sustainable alternatives to high-carbon energy sources, which might be able to enhance energy accessibility, climate resilience and energy security (Ali *et al*., 2023). Studies primarily focus on diffusion of energy generation sources through a rise in renewable sources (Iyer *et al*., 2015; Raven *et al*., 2016), addressing user attitudes towards energy usage (Muhoza and Johnson, 2018) and starting new business models considering the nature of energy use (Hoggett, 2014; Richter, 2012). The diffusion of energy sources also depends on use of eco-friendly technologies that can lead to sustainable growth (Saqib *et al*., 2023; Ofori *et al*., 2023; Ali *et al*., 2023). Hence, the recent studies on energy transition focus mainly on the socio-technical aspects of the transition. However, energy transition also has socio-political aspects.

The socio-political nature of energy transition is embedded in the existing gender inequalities. The concept of gender is related to the roles, behaviours and expectations that are socially designed for men and women (Johnson *et al*., 2019). The inequalities arise owing to the socially constructed differences between men and women, which is addressed by SDG 5. Earlier studies conducted in the global South have pointed at the presence of social inequalities regarding access to energy. The gendered nature of energy has gained prominence with research hinting at energy poverty and reliance on non-renewable sources of energy such as charcoal, dung and wood for conducting household chores (Fingleton-Smith, 2018). The unavailability of non-commercial fuels and limited availability of commercial fuels such as electricity, gas and kerosine makes it difficult for women to procure the necessary fuel. Hence, affordable energy sources will reduce hardship of women and make their life easier (J. K. Parikh, 1995). It will also address energy poverty at the household level by enabling them to have access to electricity that can solve their issues and improve their living standard (Simionescu *et al*., 2023). Studies have shown a strong association between energy poverty at the household level and women's health, education, availability of time and information accessibility (J. Parikh, 2011; Winther *et al*., 2020). Considering the effect of energy poverty on women, the transition to renewable sources of energy has been regarded as a way of relieving women from the drudgery and thereby improving their life (Mohieldin *et al*., 2022).

However, energy has been assumed to be gender-neutral upon presuming that both men and women have equal access to all sources and technologies related to energy. The assumption foregoes the gender dimension; hence, it becomes important to adopt a gendered lens for understanding "*the structures of power and exclusion (that) shape who benefits from and who is burdened by available energy technologies*" (Bell *et al*., 2020).

The prevailing gender inequality in the energy sector bears a reflection of the power asymmetry from the 1970s (Mang-Benza, 2021). The unequal participation of women in decision-making processes related to energy transition has resulted from gender blindness in the energy policy (Moser, 2012). The gender blindness has gradually turned into a myopia with mimicking of male-dominated practices from the fossil fuel sector in the renewable energy sector. The myopia has been termed a "hangover legacy" in energy systems (Mang-Benza, 2021). Women's representation in the decision-making positions of the energy sector in the European Union (EU) was found to be less and this resulted in gender inequalities in energy transition (Clancy and Feenstra, 2019). Di Vaio *et al*. (2023) supported this fact in their study, wherein they observed that women need to be given authoritative positions in the shipping sector to avoid risks related to gender bias. In addition, women must be given training to increase their representation through their presence in administrative positions. Hence, it is possible that the absence of women in the decision-making bodies probably results in the non-incorporation of the women's perspective in the designing of energy policy. In a study on Cambodia, Thailand and Vietnam regarding grid-connected renewable energy, it was found that women are included in neither the national gender equality policies nor the plans on renewable energy (Resurrección and Boyland, 2017). Similarly, in another study on the BASIC group (Brazil, South Africa, India and China), it was observed that gender inequalities are aggravating with the implementation of renewable energy sources, excluding South Africa (Amorim and Teixeira, 2018). The framing of gender policies and energy services has been done in isolation. Herein lies the probability of non-attainment of gender equality (SDG 5) in the energy sector, which might also be the reason behind the non-attainment of SDG 7.

2.1 Research gap

The literature review shows that the energy transition process is gender biased. Exclusion of these views might diminish the possibility of attaining gender equality, *i.e.*, SDG 5 by addressing the prevailing inequalities in the energy sector. This social imbalance might be the reason behind the non-attainment of SDG 7. Hence, internalizing social imbalance by realigning the energy policy framework is needed. Addressing this issue might lead to crucial policy interventions for the USA, as gender mainstreaming is yet to be realized in the energy transition process. This research gap is addressed in the present study.

3. Model and Data

3.1 Model design

Women are major victims of energy poverty. Besides, procurement and use of fossil fuel energy consume their time and deteriorate their health. The lack of female representation in the boards of energy generation firms and the gender employment gap in the energy sector show the prevailing gender inequalities. The spillover effect of these inequalities is captured using the *Gender Inequality Index*, which defines the lack of opportunities and rights that women experience in three areas of human development, *i.e.*, education, health and empowerment. Moving up the energy ladder might solve this issue, and it is captured using the *Energy Transition Index* developed by Sinha *et al*. (2023).

Nevertheless, the energy transition needs technological innovation to fulfil the pro-growth objectives alongside internalizing the social externalities. However, mitigating political risk is important for attracting energy sector investments. Further aggravating accomplishment of these objectives, there is a need to address the gender inequalities considering the imperative role of women in energy transition. The USA has taken legal steps towards attaining equal treatment for women as it will lead to reduction in the gender employment gap and promote women into top managerial positions. This is captured using the *Women, Business and Law Index*. In addition, the process of energy transition can gain speed through implementation of stringent environmental policies that explicitly or implicitly charge for polluting or harming environment. This stringency is captured using the *Environmental Policy Stringency Index*.

Following the above discussion, the theoretical model for analysing gender inequality in the energy transition scenario can be depicted as follows:

$$GII = f(ETI, PR, WBL, STR) \tag{1}$$

where *GII* is the Gender Inequality Index, *ETI* is the Energy Transition Index, *PR* is the Political Risk, *WBL* is the Women, Business and Law Index, and *STR* is the Environmental Policy Stringency Index.

Following the theoretical model, the testable empirical models for gender inequality with respect to energy transition for the country *I* and the time *t* can be presented as:

Model 1:

$$GII_{it} = a_0 + a_1 ETI_{it} + a_2 PR_{it} + a_3 WBL_{it} + a_4 STR_{it} + \epsilon_{it} \tag{2}$$

Women play a crucial role in energy usage; hence, it is important to examine whether the energy transition process is gender inclusive. The energy transition process can be affected by political risk, stringent environmental policies and presence of laws to eliminate discrimination against women. Hence, these factors can moderate the effect of energy transition on gender. In addition, it is crucial to examine whether political risk deters the energy transition process while also hindering gender inclusivity. Considering the need to understand the moderating effect, Equation (2) can be framed as:

Model 2:

$$GII_{it} = b_0 + b_1 ETI_{it} + b_2 PR_{it} + b_3 WBL_{it} + b_4 STR_{it} + ETI_{it} \times \left(b_5 PR_{it} + b_6 WBL_{it} + b_7 STR_{it} \right) + \\ + ETI_{it} \times PR_{it} \times \left(b_8 WBL_{it} + b_9 STR_{it} \right) + \epsilon_{it} \tag{3}$$

The marginal impact of these factors can be expressed in the form of elasticities as depicted in Equation (4).

$$\frac{\partial GII_{it}}{\partial ETI_{it}} = \begin{cases} \dfrac{\partial GII_{it}}{\partial ETI_{it}} \,|\, no\, moderation = a_1 \\ \dfrac{\partial GII_{it}}{\partial ETI_{it}} |with\, moderation = b_1 + \left(b_5 PR_{it} + b_6 WBL_{it} + b_7 STR_{it} \right) + \\ \qquad + ETI_{it} \times PR_{it} \times \left(b_8 WBL_{it} + b_9 STR_{it} \right) \end{cases} \tag{4}$$

Regarding the marginal effect of energy transition as depicted in the form of elasticities in the presence of other factors considered in the model, certain conditions would arise. The moderating effect can result in different probabilities that are explainable through the conditions demonstrated below:

$$\begin{cases} \text{Condition1}: \; a_1 > b_1 + \left(b_5 PR_{it} + b_6 WBL_{it} + b_7 STR_{it} \right) + ETI_{it} \times PR_{it} \times \left(b_8 WBL_{it} + b_9 STR_{it} \right) \\ \text{Condition2}: \; a_1 < b_1 + \left(b_5 PR_{it} + b_6 WBL_{it} + b_7 STR_{it} \right) + ETI_{it} \times PR_{it} \times \left(b_8 WBL_{it} + b_9 STR_{it} \right) \\ \text{Condition3}: \; a_1 = b_1 + \left(b_5 PR_{it} + b_6 WBL_{it} + b_7 STR_{it} \right) + ETI_{it} \times PR_{it} \times \left(b_8 WBL_{it} + b_9 STR_{it} \right) \end{cases} \tag{5}$$

These conditions depict different moderating impacts of model parameters affecting the gender inclusiveness of energy transition. Condition 1 shows that energy transition has the highest impact on gender inequality in the absence of moderation, thereby indicating the lacuna of environmental and gender policies. This unfavourable situation might make the effort of policymakers futile. Condition 2 shows effectiveness of environmental and gender policies in improving gender inclusivity in the energy transition. Policymakers need to sustain this situation to reduce gender inequality. Condition 3 refers to the boundary condition, where the impact of moderation is yet to become visible.

3.2 Empirical schema

The empirical model considered in this study can have endogeneity issues because it is a reduced-form model. Other than the variables considered, *GII* might be affected by other factors, thereby pointing at an incidence of omitted variable bias. The measurement issues need to be addressed for designing a robust policy framework. For this reason, the data are analysed using fully modified ordinary least squares (FMOLS), as (a) the $N > T$ condition is not fulfilled, and (b) the panel heterogeneity needs to be taken into account. The use of FMOLS will help examine the impact of each of the variables on gender inequality. Nevertheless, the implementation at the policy level needs understanding of the moderating effect of political risk on the marginal impact of energy transition on gender inequality.

In addition, quantile regression is used for long term estimation, as this method gives the flexibility of analysing the data through various quantiles. This will enable a deeper understanding of the impact of model parameters on the dependent variable.

3.3 Data

The study is conducted on the USA for the period 1990–2021. The period is constrained by the data availability of the variables. The data on the Gender Inequality Index are gathered from the UN (2023). This index provides insights into the gender discriminations existing across three dimensions: health, empowerment and the labour market. The Energy Transition Index data are calculated following the process developed by Sinha *et al*. (2023). The transition can be achieved by gauging the movement of countries along the energy ladder. The movement along the energy ladder is captured using the movements along cleaner non-renewable energy sources and efficient renewable energy sources. Data on political risk are gathered from the Political Risk Services International Country Risk Guide (Political Risk Services, 2023). The risk is measured using 12 components across political and business dimensions related to voice and accountability, political stability, government effectiveness, regulatory quality, law and order, and control of corruption. Data on the Environmental Policy Stringency Index are collected from the OECD Environment Statistics (OECD, 2022). They measure the degree of stringency related to environmental policies concerning pollution of the surroundings for which an explicit or implicit price needs to be paid. Lastly, the data related to the Women, Business and Law Index are gathered from the World Development Indicators (WB, 2023). The index is developed for eight indicators, *i.e.*, mobility, workplace, pay, marriage, parenthood, entrepreneurship, assets and pensions. It measures the global progress towards gender equality with respect to law.

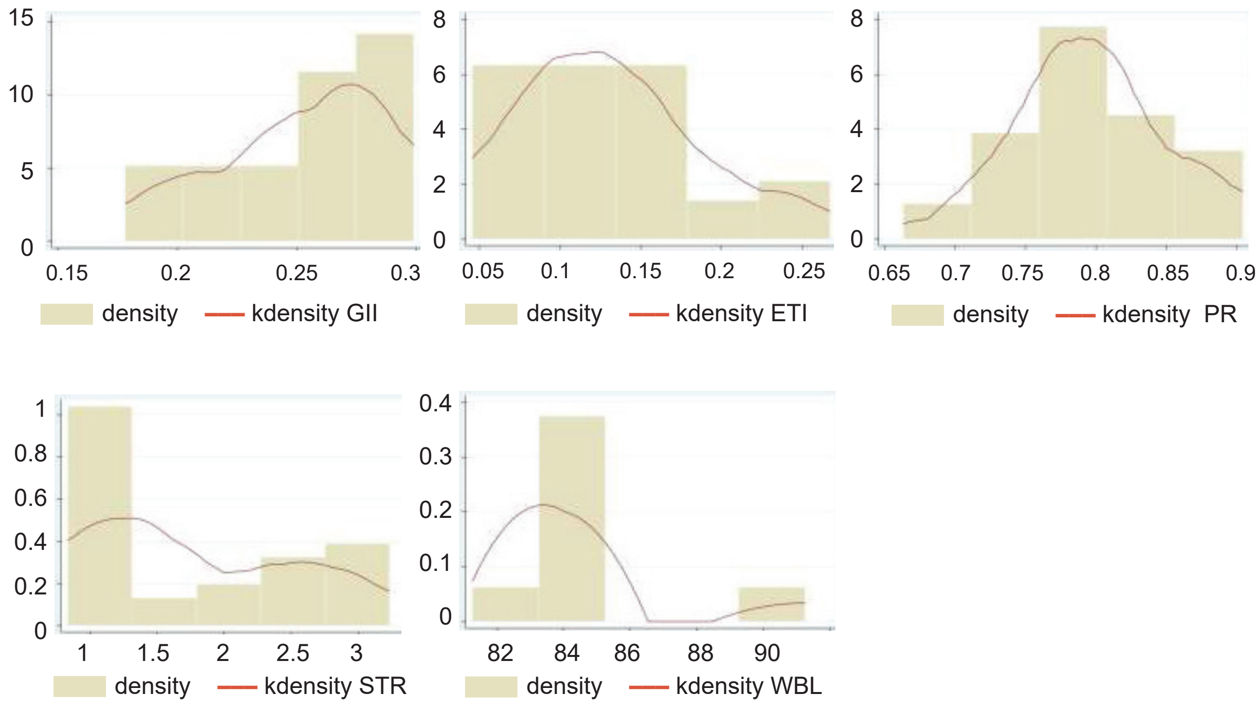
A snapshot of the data is reported in Table 1. The skewness and kurtosis results indicate the possibilities of leptokurtic distribution in the model parameters. This also shows the extreme tendencies in the data. The kernel distributions of the data shown in Figure 2 corroborate this argument. The skewed distribution of the data indicates the hidden nonlinearities in the hypothesized association. It sanctions the application of the quantile modelling approach for understanding the nuances of association at a deeper level.

Table 1: Descriptive statistics

Statistics	*GII*	*ETI*	*PR*	*WBL*	*STR*
Mean	0.2521	0.1318	0.7955	84.3750	1.7894
Median	0.2570	0.1262	0.7936	83.7500	1.4583
Standard Deviation	0.0365	0.0557	0.0551	2.7679	0.7718
Min	0.1780	0.0457	0.6629	81.2500	0.8333
Max	0.2990	0.2673	0.9047	91.2500	3.2333
Skewness	−0.5758	0.6312	−0.0003	1.8112	0.4931
Kurtosis	2.2855	2.8072	2.9277	5.2881	1.7513

Source: Author's own calculations

Figure 2: Kernel density distribution of the variables



Source: Author's own elaboration

4. Results and Discussion

4.1 Initial model diagnostics

A policy-oriented empirical model might be susceptible to the estimation bias, as the policy parameters might demonstrate multicollinearity. Hence, the fit of the model needs to be checked before analysing it. For checking the model fit, the least angle regression method with the lasso algorithm is used. This method selects the model parameters until the lowest value of Mallo''s Cp is achieved. Table 2 presents the estimation, which confirms selection of all the model parameters. In addition, the validation of model parameters is done by examining the multicollinearity issues, and the results of multicollinearity statistics are presented in Table 3. The results of augmented Dickey-Fuller (ADF) (Dickey and Fuller, 1979), Phillips-Perron (PP) (Phillips and Perron, 1988) and Kwiatkowski-Phillips-Schmidt-Shin (KPSS) (Kwiatkowski *et al.*, 1992) unit root tests show first-order integration among the model parameters. Next, the Johansen cointegration test results in Table 4 show a cointegrating relationship among the variables.

Table 2: Least Angle Regression Estimates for parameter selection

Step	Mallow's Cp	R-Square	Action
1	376.5398	0.0000	–
2	186.1152	0.4733	Add Environmental Policy Stringency
3	5.8118	0.9217	Add Women, Business, and the Law
4	6.3767	0.9253	Add Energy Transition
5	5.0000*	0.9336	Add Political Risk

Note: * indicates the minimum Mallow's Cp.
Source: Author's own calculations

Table 3: Summary of Initial Model Diagnostics

Variables	Multicollinearity statistics		ADF Unit root test		PP Unit root test		KPSS Unit Root Test	
	VIF	Tolerance	Level	1st Difference	Level	1st Difference	Level	1st Difference
Gender Inequality	–	–	2.270	−4.852***	2.916	−4.884***	0.595	0.0497
Energy Transition	1.75	0.5708	−1.863	−7.294***	−0.671	−7.471***	0.213	0.0224
Political Risk	1.72	0.5814	−2.436	−5.774***	−2.256	−6.153***	0.401	0.0345
Women, Business, and the Law	1.97	0.5070	−0.551	−5.604 ***	−0.503	−5.620***	0.328	0.0750
Environmental Policy Stringency	2.51	0.3988	−0.604	−6.707***	−0.477	−6.813***	0.297	0.0407

Note: ***, **, * show significance at 1%, 5%, and 10% levels, respectively.
Source: Author's own calculations

Table 4: Results of Johansen Cointegration Test

Maximum Rank	Parameters	LL	Eigenvalue	Trace statistic	5% Critical Value
0	55	249.3186	–	71.6305	68.52
1	64	264.2063	0.64183	41.8550*	47.21
2	71	272.4026	0.43179	25.4624	29.68
3	76	279.6213	0.39216	11.025	15.41
4	79	283.6153	0.24077	3.037	3.76

Note: * indicates the number of cointegrating equations selected.
Source: Author's own calculations

4.2 Analysis of long-run coefficients

The initial model diagnostics approve the estimation of long-run coefficients of the empirical models. The FMOLS and quantile regression are applied to calculate the long-run coefficients of the model parameters, and the results are presented in Table 5. Both Model 1 (without moderation) and Model 2 (with moderation) are assessed for capturing the effect of energy transition on gender inequality.

Table 5: Results of FMOLS estimation

Variables	Model 1	Model 2
Energy Transition	0.0494**	15.0959***
Political Risk	0.2327*	–1.1492***
Women, Business, and the Law	–1.6185***	–8.0661***
Environmental Policy Stringency	–0.2748***	–0.1356
Energy Transition × Political Risk	–	2.4602
Energy Transition × Women, Business, and the Law	–	–3.4379***
Energy Transition × Environmental Policy Stringency	–	0.0018
Energy Transition × Political Risk × Women, Business, and the Law	–	–0.7084
Energy Transition × Political Risk × Environmental Policy Stringency	–	–0.2502*
Constant	6.0849***	34.2614***
Adjusted R^2 values	0.9021	0.8807

Note: ***, **, * show significance at 1%, 5%, and 10% levels, respectively.
Source: Author's own calculations

The global energy transition process suffers from gender bias in the energy sector. According to the European Parliament's Policy Department for Citizens' Rights and Constitutional Affairs, the energy sector is the most gender-imbalanced sector (Clancy and Feenstra, 2019). Considering the necessity of transitioning to cleaner energy sources and the gender bias in the energy sector, it is imperative to identify the effect of the transition on gender inequality. Moreover, the addition of new sources of energy might be able to resolve the problems that women encounter owing to energy poverty. Furthermore, the employment of women in the clean energy generation is slightly higher than in energy generation using fossil fuels (Ferroukhi *et al*., 2019). Nevertheless, the results obtained in this study show that energy transition positively affects gender inequality, *i.e.*, it further adds to the existing gender inequalities (see Table 5). One of the possible reasons might be lack of representation of women in the boards of companies related to energy in the USA. The finding is in line with those of the study by Allison *et al*. (2019) on energy firms, which shows that women are overshadowed in both business ownership and corporate leadership. Therefore, it is evident that SGD 7 can be attained by considering gender perspectives within the energy policy framework. Furthermore, this incorporation will help augment gender equality (SDG 5) primarily in the energy sector. Hence, there is a complementary association between SDG 5 and SDG 7. This discussion elucidates the need for energy transition for mitigating climate change and reducing energy poverty. Hence, the US government has designed stringent environmental policies to charge for environmental degradation. It helps diminish air pollution by encouraging transition to cleaner energy sources (Kazemzadeh *et al*., 2023; Smith *et al*., 2009). The advancement in the transition process and availability of better energy sources might be fruitful for women, as it can lead to an increase in cleaner energy accessibility. Hence, environmental stringency must have a positive impact on gender, *i.e.*, it might help augment gender equality. The results presented in Table 5 reiterate that environmental stringency affects gender inequality .

Political risk might hinder energy transition by limiting energy sector investments (Zhang *et al*., 2022). It might cause decline in job creation in the renewable energy sector, thereby shrinking opportunities for women. Women tend to lose jobs faster than men during political instable situation (Soyyiğit *et al*., 2023). Besides, incidence of extreme violence limits women's participation because of concern about vulnerability of their children and home (Becker, 1975). In addition, sexual violence against women might hinder their willingness to join the labour force (Chakraborty and Lohawala, 2021; Gu *et al*., 2022). Therefore, political risk also adds to gender inequality, as has been put forth in the results given in Table 5. Poor female representation might restrict imbibing gendered perspective in energy policies.

The US government has taken legal steps towards reducing the gender employment gap by smothering gendered division of labour at work, ensuring safety at work through laws against sexual violence at work, promoting mobility, permitting women the right of decision-making and voicing against domestic violence, and supporting women through parental leave. Byker (2016) has shown that paid parental leave increases attachment of women towards their job. The results presented in Table 5 shows that Women, Business and Law negatively affects gender inequality. Flexibility of legal support might enable women to become decision makers, both at firm and ministerial levels.

4.3 Analysis of static marginal impacts

External policy instruments might influence the policy framework. So, the impact of energy transition on gender inequality might be moderated. The impact is measured through Model 2 and the results are presented in Table 5. The marginal impact is encapsulated through Static Marginal Impact calculated at sample means of Political Risk, Women, Business and Law and Environmental Policy Stringency (see Table 6). Obtaining these moderating impacts will enable the policies to be inclusive and robust.

Table 6: Marginal impacts of Energy Transition Index in elasticity terms

	Marginal Impact of Energy Transition
Model 1	0.0494
Model 2	−1.0471

Source: Author's own calculations

The marginal impact of energy transition on gender inequality examined under the *Ceteris Paribus* condition (Model 1) is found to be 0.0494. However, the presence of Political Risk, Women, Business and Law and Environmental Policy Stringency might moderate the marginal effect as demonstrated through Equation (3). The plausible effect of moderation is depicted through the conditions given in Equation 4. The conditions mentioned state that (a) the negative externalities of political risk might have increased effect than the positive externalities of Women, Business and Law and Environmental Policy Stringency; (b) the positive externalities of Women, Business and Law along with the presence of Environmental Policy Stringency Index might help reduce the prevailing inequalities; and (c) negative and positive externalities might have equal impact. The marginal impact of energy transition on gender inequality under moderation is −1.0471. The negative marginal impact of energy transition on gender inequality indicates the favourable influence of Women, Business and Law and Environmental Policy Stringency over Political Risk, and thereby complying with Condition 2 in Equation 5.

The results indicate the advantageous role of policies and laws in shaping the impact of energy transition on gender inequality. With the support of laws for women and stringent policies for environment, energy transition might relegate the prevailing gender inequalities. Yet, political risk might limit energy sector investments, resulting in a decrease in jobs. Furthermore, women lose jobs faster than men during times of extreme violence.

Nevertheless, the laws favouring women play a supportive role, and thereby downgrade the impact of political risk. In addition, the stringency of environmental policies encourages transition to cleaner energy sources and can create more job opportunities (Allison *et al.*, 2019). Thus, the energy transition might espouse the increased number of jobs accessible under the provision of laws to encourage women to join labour force. So, the negative impact of energy transition on gender inequality is found to fade under policy intervention. However, the persisting gap in achieving gender equality highlights the need of revamping existing policies for gender mainstreaming in the energy sector.

Though a preliminary picture of the moderating effect of factors on the association between energy transition and gender inequality is observed, there is need of a deeper understanding of the policy instruments. It would help scrutinize the dynamism of the economic structure and interactions among the policy mechanisms.

4.4 Analysis of quantile regression

For gaining a deeper insight, the empirical model is estimated using quantile approach. Following the estimation of quantile autoregressive unit root test by Koenker and Xiao (2004) (see results in Table 7), the quantile regression for long run estimates calculated at quantiles 0.25, 0.50 and 0.75 are presented in Table 8 and the corresponding marginal impacts of energy transition are depicted in Figure 3. Herein, the results related to no moderation have been discussed. The results show that energy transition positively affects gender inequality. The coefficients across quantiles show that the initial stages of energy transition have a higher effect on aggravating gender inequalities. The effect declines as the transition process reaches halfway, but again intensifies near the final stage. However, the effect in the final stage of transition is less than the initial stage. The reason might be related to the gender employment gap in the energy sector of the USA. So, the initial stages of energy transition might create job opportunities for men, thereby enhancing gender inequality. Nevertheless, with the increase in job opportunities in the renewable energy sector, the chances of women getting employed might upsurge and this might reduce the gender gap. However, the absence of women in decision-making positions of energy companies and in the ministry might act as hindrance. Hence, the chances of women employment might decrease in the final stage of energy transition, as shown in Table 8.

Table 7: Results of Quantile Autoregressive Unit Root test

Variables	Quantile (0.25)	Quantile (0.50)	Quantile (0.75)
Gender Inequality	−2.1086	−4.3484	−3.2027
Energy Transition	−5.7227	−4.7969	−2.9393
Political Risk	−3.7903	−3.2344	−1.7143
Women, Business, and the Law	0.0000	−0.3522	0.0000
Environmental Policy Stringency	−6.2323	−4.7415	−2.6757

Note: all the variables are at their first differences.
Source: Author’s own calculations

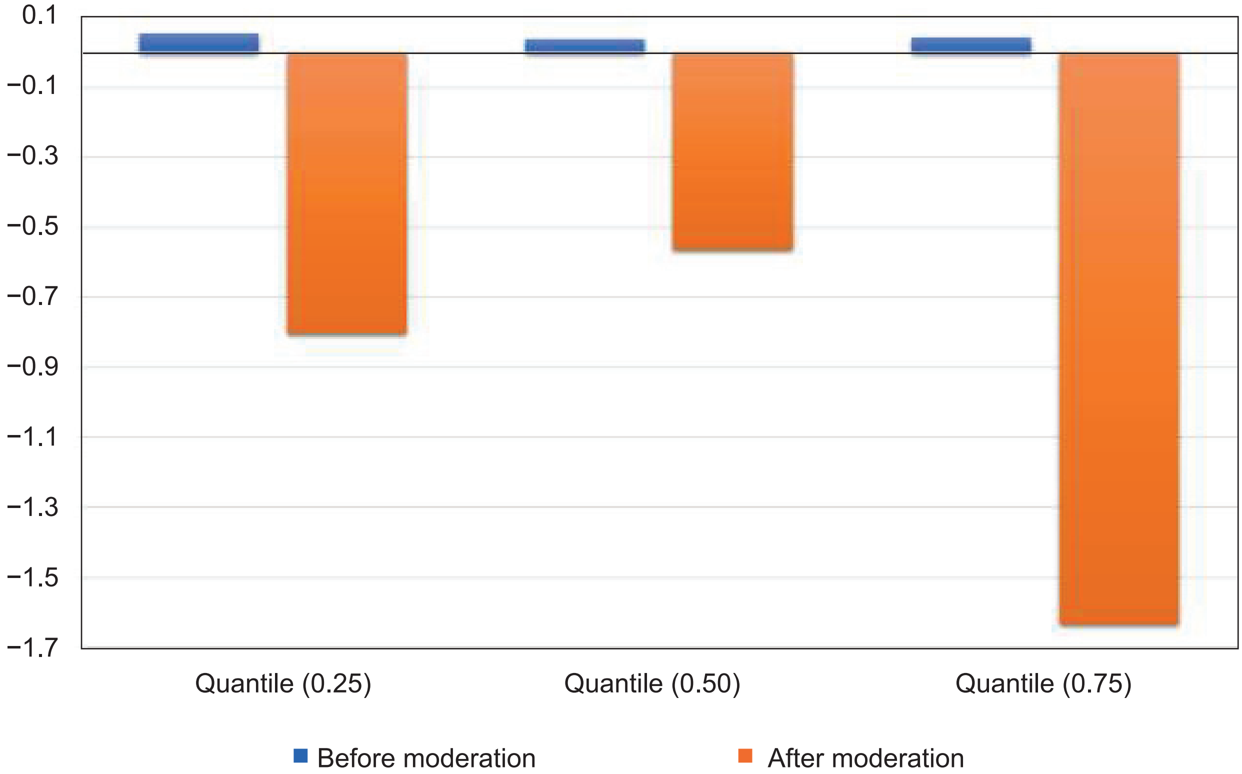
Table 8: Results of Quantile Regression

Variables	Quantile (0.25)		Quantile (0.50)		Quantile (0.75)	
	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2
Energy Transition	0.0544	14.8719**	0.0380	23.0624**	0.0447	16.7756**
Political Risk	0.0750	−1.2042**	0.0473	−0.8168	0.1182	−2.1976**
Women, Business, and the Law	−1.5601**	−7.7717**	−1.5198**	−10.0443**	−1.2852**	−9.4578**
Environmental Policy Stringency	−0.2545***	−0.1025	−0.2798***	−0.1508	−0.3078***	−0.2040
Energy Transition * Political Risk	–	4.1200	–	16.1501	–	−2.0002
Energy Transition * Women, Business, and the Law	–	−3.3888**	–	−5.2319**	–	−3.8410**
Energy Transition * Environmental Policy Stringency	–	−0.0017	–	0.0474	–	0.0020
Energy Transition * Political Risk * Women, Business, and the Law	–	−1.0682	–	−3.777	–	0.1876
Energy Transition * Political Risk * Environmental Policy Stringency	–	−0.3443	–	−0.0650	–	−0.1348
Constant	5.7570**	32.8810**	5.5880**	43.1029**	4.6093**	40.2101**
Marginal impacts of Energy Transition	0.0544	−0.8007	0.0380	−0.5625	0.0447	−1.6346

Note: ***, **, * show significance at 1%, 5%, and 10% levels, respectively.

Source: Author's own calculations

Figure 3: Marginal effect of Energy Transition on Gender Inequality across the quantiles



Source: Author's own elaboration

Political risk also has a similar effect on gender inequality. Low political risk has a higher effect on gender inequality than during medium political risk. Politically stable situation might compel women to not join the labour force owing to steady income of the primary earner. However, the primary earner becoming unemployed during medium political risk situation might compel women to join the labour force. This situation is theoretically referred to as the *Added Worker effect* (Martín-Román, 2022). Studies conducted by Menon and Van der Meulen Rodgers (2015), Kreibaum and Klasen (2015) and Alix-Garcia *et al*. (2022) found that civil war in Nepal, Vietnam war and Triple Alliance War in Paraguay have increased the likelihood of women's decision to work outside home. So, medium political risk situation can augment gender equality. Now, high political risk might lead to women unemployment and anxiety-led withdrawal from labour force (Becker, 1975; Berrebi and Klor, 2010). Energy sector investments and subsequent job creation are also hindered in this situation. It might indicate the *Discouraged Worker effect* (Martín-Román, 2022). Under this situation, workers might feel disheartened about getting any job considering the downturn or crisis in an economy. It is possible that those workers give up looking for jobs and even leave the labour market. In the case of women, this situation will escalate the prevailing gender gap. Therefore, gender inequality increases during high political risk, as reported in Table 8.

Both Women, Business and Law and Environmental Policy Stringency negatively affect gender inequality. The impact of Women, Business and Law gradually increases along the quantile progression. These laws enable women to fight against discrimination across social facets. However, the effect of Environmental Policy Stringency gradually diminishes along the quantile progression, thereby augmenting gender inequality. Policy stringency catalyses energy transition (Kazemzadeh *et al*., 2023). Rise in cleaner energy production leads to rise in job creation. Hence, although having the potential to reduce gender inequality, the effect slowly diminishes owing to the gender-imbalance in the energy sector. Herein lies the challenge for policymakers to gender streamline energy policies.

Understanding of the moderating effects at a deeper level is obtained by calculating marginal impacts across the quantiles. Results (see Table 8) show that the negative impact of energy transition on gender equality reverses across the quantiles under moderation. The female-supportive laws help energy transition to reduce gender inequality. Yet, high policy stringency is found to make energy transition process gender biased. The probable reason might be the lack of female representation in the board of energy firms in the USA. Also, the moderation of political risk reduces gender inequality. The interaction of Women, Business and Law with political risk is found to increase gender inequality, while the interaction of Environmental Policy Stringency with political risk marginally reduces gender inequality. The politically unstable situation is found to dissuade the positive effects of Women, Business and Law and Environmental Policy Stringency on gender equality, thereby affecting the marginal impact of energy transition. Therein lies the policy challenge.

5. Conclusion and Policy Implications

The study has examined the moderating effect of Political Risk, Women, Business and Law and Environmental Policy Stringency with respect to the effect of energy transition on gender inequality. It has been observed that in the presence of the other factors, the effect of energy transition on gender inequality is negative. Quantile regression outcomes show the marginal effect of energy transition on gender inequality to be changing across the quantiles. The policy implications are drawn on the study outcomes.

5.1 Policy framework

The initial objective must be to address the political risks for restoring domestic structural stability. Furthermore, the USA should plan for political exigencies, so that the disaster recovery mechanism following any geopolitical shock can be effective. This would be helpful for improving safety and security, which would in turn minimize rent-seeking behaviour in the public systems. The implementation of this phase will increase assurance of safety, resulting in higher investments in renewable energy technologies. Besides, sense of security among women will ensure their participation in the labour force. This phase will help to develop a policy environment that can increase participation of women will be the first steppingstone towards reducing gender imbalance in the energy sector and overall gender inequality.

The second phase of the framework should focus on sustaining female participation. Environmental policy stringency, as a transition driver, might play a crucial role in this phase. In this phase, rise in the job opportunities increases in the energy sector might open new avenues for women. This would in a way reduce gender inequality. However, the increased policy stringency has adverse effect on gender equality, which can be tackled by the presence of women in the decision-making fronts. It will help devise strategies for women welfare policies and ensure support from the top management as well as government in accomplishing the desired objective.

Upon assuring a stable environment and sustained participation of women, it is impertinent to build a supportive environment through proper implementation of laws. The laws along with female representation in the political system will help ascertain transparency in the economic structure. Hence, the third phase must guarantee apposite implementation of laws favouring women. This will help reduce the gender disparity existing in the energy sector. Lastly, operationalization of these three phases might further facilitate energy innovation by incorporating cognitive diversity in energy firms. Hence, implementation of this policy framework will help accomplish the objectives of SDG 5 along with a promise of fulfilling SDG 7.

5.2 Limitations and future directions

The study is conducted for the USA to examine the marginal impact of energy transition on gender inequality. It is important to see this association in other developed and developing countries. Moreover, firm-level data on women employment in energy sector could have brought additional insights. Yet, the implications drawn in this study might help benchmark the gender mainstreaming the energy policies in a developed nation. Therein lies the contribution of the study. Future studies can also use data on women at different positions in the energy sector and scrutinize their impact on prevailing gender inequalities.

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