

# **Beyond Federalism: Climate Readiness and the Gendered Effects of Fiscal Decentralization**

February 2026

Atrayee Choudhury<sup>Ψ</sup>

## Abstract

---

This study revisits the fiscal decentralization–women’s rights nexus by introducing climate readiness as a critical conditioning mechanism. Using a global sample mix over recent decades, we employ dynamic panel threshold regression, conditional quantile regression, and system GMM to examine how decentralized governance interacts with adaptive capacity to shape women’s legal and economic rights, measured using the novel Women, Business and the Law index by World Bank. Fiscal decentralization is initially observed to weaken women’s rights in low–climate-readiness settings but becomes significantly positive beyond a critical readiness threshold. These results remain robust across alternative measures, model specifications, and geographic, institutional, and political subsamples. Furthermore, collectivist societies are seen to partially offset weak formal capacity through collective action, while individualistic contexts exhibit weaker community mobilisation despite favourable institutions. Overall, the findings highlight climate readiness and cultural context as pivotal enabling conditions for translating decentralization reforms into sustainable gender-equitable development outcomes.

---

Key words: Fiscal Decentralization; Climate change; Dynamic panel threshold model; Culture

JEL classifications: H77; Q48; C18; Z13

---

<sup>Ψ</sup>National Institute of Public Finance and Policy, New Delhi, India. [atrayee.choudhury@nipfp.org.in](mailto:atrayee.choudhury@nipfp.org.in) ; [atray.choudhury@gmail.com](mailto:atray.choudhury@gmail.com)

## 1. Introduction

The literature on public finance and political economy has placed a strong emphasis on fiscal and political decentralization in recent decades, especially when discussing development outcomes, state capacity, and governance reform. Numerous studies, both theoretical and empirical, have looked at how decentralization affects fiscal restraint, public service delivery, macroeconomic stability, and allocative efficiency (Oates, 1972; Prudhomme, 1995; Rodden, 2004; Treisman, 2007). A move away from solely efficiency-based concerns toward development-oriented evaluations of decentralized systems can be seen in the more recent expansion of the focus to include broader socio-economic outcomes like poverty reduction, inequality, health, education, and environmental governance (Bardhan & Mookherjee, 2006; Faguet, 2014; Martinez-Vazquez et al., 2017). Even with this expanding body of work, decentralization research has not consistently addressed distributional and rights-based consequences for various social groups.

The research on decentralization has a notable gap when it comes to gender-specific development outcomes, particularly the legal and economic rights of women. The majority of empirical studies on decentralization still rely on aggregate welfare indicators, such as income levels, poverty rates, or average service provision, which mask gendered disparities, despite the fact that gender equality is now widely acknowledged as a development goal and a catalyst for inclusive growth (Duflo, 2012; Kabeer, 2016). Rather than explicitly measuring women's legal status, labor market involvement, or economic agency, gender frequently enters the analysis indirectly through health or education results. Because of this, the connection between decentralized governance structures and women's livelihood rights is still unclear from a theoretical and empirical standpoint.

### *1.1 Theoretical literature evidence*

Theoretical evidence regarding the effect of decentralisation on women's legal and economic empowerment are vividly divided along the lines of first- and second-generation theories of fiscal federalism. First-generation theories, rooted in normative public finance, assume benevolent and welfare-maximising governments. In this framework, decentralisation enhances accountability, improves information flows, and allows sub-national governments to better tailor policies to local needs, including those of marginalised groups such as women (Oates, 1972; Musgrave, 1959). Greater proximity between policymakers and citizens may increase responsiveness to gender-specific concerns, potentially strengthening women's access to legal protections, employment opportunities, and economic resources.

Second-generation theories, on the other hand, place more stress on elite capture, strategic behavior, and political economy restrictions in decentralized systems. Frequently at the expense of politically weaker communities, these models illustrate how local governments may react to populist impulses,

prevailing interest groups, or deeply ingrained social conventions (Bardhan & Mookherjee, 2000; Besley & Coate, 2003; Rodden, 2006). Decentralization may exacerbate already-existing disparities in nations with restrictive gender norms by giving local elites more authority and less motivation to promote women's economic and legal rights. According to this viewpoint, it is conceivable that fiscal decentralization will worsen the results of women's empowerment outcomes, particularly if there are no robust institutional safeguards.

The absence of thorough, comparable measurements of women's legal and economic rights has made it difficult to empirically evaluate these conflicting theoretical expectations. This study addresses this limitation by employing the Women, Business and the Law (WBL) index developed by the World Bank. In a number of important areas, including as mobility, employment rights, compensation, marriage, motherhood, entrepreneurship, assets, and pensions, the WBL index offers a methodical, cross-national assessment of gender-based legislative restrictions (World Bank, 2023). The WBL index provides a more accurate and policy-relevant measure of gender empowerment than outcome-based indicators alone because it captures de jure legislative frameworks that have a direct impact on women's economic involvement and agency. To the best of our knowledge, this index has not yet been systematically employed in the fiscal decentralisation literature, particularly in cross-country panel settings, thereby allowing this study to make a novel empirical contribution.

By integrating climate change readiness as a mediating institutional channel, this study builds on these theoretical conflicts and attempts to reconcile the conflicting predictions of first- and second-generation decentralization theories. We contend that a nation's ability to plan, fund, and carry out policies for climate adaptation and mitigation is a reflection of its overall level of governance, infrastructure readiness, and intergovernmental collaboration. Decentralized fiscal systems may function inside stronger institutional frameworks in climate-ready contexts, lowering the potential for elite capture and short-term populism while boosting accountability and long-term policy focus. Using advanced panel econometric techniques that allow for cross-country heterogeneity and asymmetry, the analysis examines whether climate readiness conditions the impact of fiscal decentralisation on women's legal and economic rights. The study further controls for geographic, political, institutional, and cultural factors to provide a robust assessment of the decentralisation–gender nexus and the role that climate governance plays in shaping it.

## *1.2 Empirical literature evidence*

Decentralized governance structures are generally linked to improvements in gender-related development outcomes, according to empirical research that supports first-generation theories of fiscal decentralization. This is especially true when local governments have sufficient administrative capacity and accountability mechanisms. According to cross-national and subnational evaluations, decentralization improves access to health care, education, and employment possibilities for women,

strengthening their economic agency and making public policy more responsive to their needs (Crook & Manor, 1998; Faguet, 2012). Research from Latin America and India shows that local political representation and decentralized spending responsibilities are associated with better maternal health outcomes, increased provision of social infrastructure that disproportionately benefits women, and higher female labor force participation (Chattopadhyay & Duflo, 2004; Rao & Kelleher, 2005). These results confirm the first-generation hypothesis that local governments can internalize gender-specific preferences by being close to citizens and having improved information flows, which promotes more welcoming legal and economic settings for women.

On the other hand, an increasing amount of empirical research that supports second-generation theories shows that decentralization can make gender inequality worse, especially in situations where institutions are weak, societal norms are deeply ingrained, or elites are captured. According to studies, local governments may provide preference to politically powerful groups, which would strengthen patriarchal systems that deny women access to economic and legal possibilities (Bardhan & Mookherjee, 2000; Beaman et al., 2012). In societies with strong traditional norms, where dominant male elites control local accountability mechanisms, decentralization is linked to lower redistributive spending and weaker enforcement of gender-equal legislation, according to cross-country evidence (Treisman, 2007; Rodríguez-Pose & Ezcurra, 2010). Furthermore, subnational assessments show that decentralization may weaken national-level pledges to gender equality by dividing policy power, resulting in unequal labor protections and legal rights for women in different regions (Bussmann, 2010; Enikolopov & Zhuravskaya, 2007). These results provide empirical backing for second-generation claims that decentralization can jeopardize women's economic and legal empowerment in the absence of robust institutional protections.

### *1.3 The role of climate change readiness as a mediating institutional factor*

Climate change readiness constitutes a critical yet underexplored institutional channel through which fiscal decentralisation may shape development outcomes, including women's legal and economic rights. Climate readiness reflects a country's capacity to anticipate, finance, and implement climate mitigation and adaptation measures through coordinated governance structures, infrastructure investment, and policy planning. Importantly, climate policy implementation is inherently multi-level, requiring effective vertical coordination between national and sub-national governments and horizontal coordination across sectors (Bulkeley & Betsill, 2005; Ostrom, 2010). Greater fiscal and institutional coherence, longer policy perspectives, and stronger sub-national administrative ability are characteristics of climate-ready regions that increase the likelihood that decentralized governance will work as first-generation theories envision. In these situations, decentralization reduces the vulnerabilities of elite capture and populist short-termism that are highlighted in second-generation models by improving accountability and policy responsiveness as opposed to fragmenting authority.

Beyond institutional capacity, climate readiness also interacts with gendered patterns of awareness, participation, and accountability. A increasing body of research indicates that women are more likely to become more ecologically conscious and involved in environmental governance since they are disproportionately impacted by climate hazards (Agarwal, 2010; Alston, 2013). Research indicates that women's involvement in local climate-related decision-making is linked to increased demand for transparency and legal enforcement, better policy compliance, and more vigilant oversight of public institutions (UNDP, 2016; Ergas & York, 2012). Women's collaborative action can be translated into wider accountability signals across levels of government in nations with greater climate readiness by means of institutionalized mechanisms that connect local climate governance to national policy frameworks. Decentralization in climate-ready environments is therefore more likely to enhance first-generation impacts, like inclusiveness and responsiveness, while reducing second-generation risks linked to regional power imbalances and discriminatory practices.

The Notre Dame Global Adaptation Initiative (ND-GAIN) Climate Readiness Index, which offers a thorough, cross-country assessment of a country's capacity to leverage investments and transform climate challenges into adaptive and mitigative outcomes, is used in this study to empirically capture this mediating role (Chen et al., 2015). The ND-GAIN readiness index incorporates economic, governance, and social aspects, such as infrastructure, investment readiness, social capacity, and institutional quality, in contrast to traditional climate indicators that only consider emissions or exposure. This makes it particularly well suited to analysing how climate governance intersects with decentralised fiscal systems and gendered development outcomes. To the best of our knowledge, the ND-GAIN readiness index has not been previously employed in the decentralisation–gender literature, allowing this study to make a novel contribution by explicitly linking climate preparedness, multi-level governance, and women's legal and economic empowerment.

According to the baseline System GMM estimates, fiscal decentralization generally has a negative impact on the Women, Business and the Law (WBL) index. This suggests that decentralized governance arrangements may initially erode the legal and economic rights of women. In situations where institutional capacity is low, this finding aligns with second-generation decentralization theories that highlight the dangers of elite capture, inadequate local accountability, and the perpetuation of patriarchal norms (Bardhan & Mookherjee, 2000; Treisman, 2007). The findings also indicate that nations with greater degrees of climate preparation considerably lessen this adverse effect. Decentralized governance is more likely to function well when there is increased institutional capacity, infrastructure investment, and multi-level coordination, all of which are indicators of enhanced climate readiness (Ostrom, 2010; Faguet, 2014).

#### *1.4. Empirical novelty*

The ability of linear fixed-effects and system-GMM estimations to formally test for non-linearity or to determine the threshold level of climate readiness at which the effects of decentralization change sign or magnitude is intrinsically limited, despite the fact that they offer valuable baseline evidence on the relationship between fiscal decentralization and women's legal and economic rights under varying degrees of climate readiness. Regime-dependent dynamics that may emerge when institutional capacity and climatic infrastructure beyond critical levels are obscured by linear models, which impose constant marginal effects (Hansen, 1999; Kremer et al., 2013). In the context of decentralised governance, such non-linearities are particularly salient, as the effectiveness of fiscal decentralisation is likely to differ fundamentally between regions with weak versus well-developed climate risk mitigation and adaptation infrastructure.

In order to overcome these drawbacks, this study uses the dynamic panel threshold GMM estimator created by Seo and Shin (2016). This estimator expands on the conventional GMM framework by incorporating regime-dependent slope coefficients and endogenous regressors and threshold variables. Despite endogeneity and weak exogeneity violations, the estimator's reliance on a first-difference transformation within a GMM framework (FD-GMM) ensures consistent and asymptotically normal estimates. Because fiscal decentralization operates under different institutional regimes—characterized by partial versus comprehensive climate readiness—where accountability mechanisms, administrative capacity, and policy transmission differ significantly, this methodological decision is particularly pertinent to the current analysis.

Furthermore, the effects of institutional variables often vary across the outcome distribution, particularly when policy impacts differ across regions and levels of development (Bitler, Gelbach, & Hoynes, 2006). In the context of fiscal decentralisation and women's legal and economic rights, such heterogeneity implies that average estimates may mask important distributional differences. Accordingly, this study examines how climate readiness regimes condition the decentralisation–women's rights relationship across the distribution of the Women, Business and the Law (WBL) index.

To capture these heterogeneous effects, we employ the dynamic conditional panel quantile regression framework proposed by Machado and Silva (2019) and combine it under the dynamic panel threshold framework. This approach extends mean-based panel estimators by allowing regressors' impacts to vary across quantiles while addressing unobserved heterogeneity and endogeneity concerns. By modelling the full conditional distribution of the WBL index, the method reveals how fiscal decentralisation and climate readiness differentially affect countries with weaker versus stronger legal and economic rights for women.

### *1.5 Accounting for geographical, political, and cultural factors*

We perform robustness checks using a sub-sample of EU countries to account for institutional, historical, and geographic homogeneity that could otherwise confuse cross-country estimates, since decentralization is a defining institutional feature of European governance (Hooghe, Marks, & Schakel, 2010; Rodden, 2006). We can determine if the relationship between decentralization and women's rights endures in environments with developed multi-level governance systems and comparatively high administrative capability owing to this subsample.

Recognising that political institutions fundamentally shape both decentralisation outcomes and the effectiveness of climate governance, we further test the robustness of our findings across political regimes with varying degrees of territorial authority. Using an index of political decentralisation following Rodden (2004), countries are classified as unitary (1), confederal (2), or federal (3). We re-estimate the threshold model for the sub-sample of unitary or less fiscally decentralised countries, thereby controlling for institutional and political heterogeneity that may jointly influence fiscal decentralisation, climate readiness, and women's legal and economic rights (Treisman, 2007; Faguet, 2014). This exercise helps isolate the effect of decentralisation from broader federal political structures.

Finally, to account for deep-seated cultural heterogeneity, we classify countries as individualistic or collectivist based on Hofstede's cultural dimensions and re-estimate the model across these sub-samples. Cultural norms influence gender roles, legal enforcement, and political participation, all of which mediate the relationship between decentralised governance and women's rights (Hofstede, 2001; Kabeer, 2016). By incorporating geographic, political, and cultural robustness checks, this study ensures that the estimated effects are not driven by region-specific institutions, political arrangements, or cultural norms.

Summing up, this study makes several significant contributions to the body of literature on the relationship between decentralization and women's rights. By using the ND-GAIN Climate Readiness Index, a new and comprehensive metric that accounts for governance capacity, infrastructure, and investment readiness in addition to more traditional climate indicators like emissions intensity or ecological footprints, it introduces climate change readiness as a possible mediating institutional factor. Second, compared to outcome-based gender indicators typically employed in decentralization studies, the analysis makes use of the Women, Business and the Law (WBL) index, which represents a novel attempt to empirically capture women's legal and economic rights across multiple dimensions—including mobility, employment, pay, marriage, parenthood, entrepreneurship, assets, and pensions.

Third, by employing advanced econometric techniques that specifically take endogeneity, non-linearity, asymmetry, and distributional heterogeneity into account—such as dynamic system-GMM, threshold GMM, and conditional panel quantile regression methods—to test the relationship between

decentralization and women's rights, the study contributes to the empirical literature. Fourth, acknowledging that these structural elements significantly influence the functioning of decentralization mechanisms, it creates and empirically assesses a conceptual framework that incorporates geographic (EU versus non-EU), political (unitary versus federal systems), and cultural (individualistic versus collectivist societies) contexts. Finally, by employing a global panel of both developing and advanced economies, the study provides macroeconomic-level evidence on the conditional effects of decentralisation on women's legal and economic empowerment, thereby enhancing the external validity and generalisability of its findings.

In short, our study thus adds to the literature body of the decentralization – women's rights nexus by 1) bringing in the mediating factor of climate change readiness using the novel index of ND-Climate gain, which is a more comprehensive indicator compared to traditional databases of emissions or ecological footprint 2) Addressing the nexus with the novel database of WBL index, which covers much comprehensive facets of rights across gendered dimensions 4) addressing the hypotheses of the nexus under advanced econometric techniques accounting for potential asymmetry and heterogeneity 5) by bringing in conceptual framework involving geographic, cultural and political contexts which influence the working mechanism of decentralization on women's legal and economic outcomes 6) Considering a global sample of both developing and non-developing countries to arrive at a macroeconomic inference regarding the decentralization – women's rights nexus.

The threshold regression results corroborate the baseline findings by revealing regime-dependent effects of fiscal decentralisation on women's legal and economic rights, conditioned by climate readiness. In countries with low levels of climate readiness, decentralisation is associated with a negative effect on the Women, Business and the Law (WBL) index, consistent with second-generation decentralisation theories emphasising weak local capacity and elite capture (Bardhan & Mookherjee, 2000; Treisman, 2007). Once climate readiness exceeds its mean threshold, this adverse relationship attenuates and reverses, indicating that stronger climate infrastructure and institutional capacity enable decentralised governance to generate more gender-inclusive outcomes. These baseline results are robust across alternate metrics of decentralization and climate change indicator, and the pattern is particularly pronounced among European Union countries, where mature multi-level governance structures and robust accountability mechanisms reinforce first-generation decentralisation effects (Hooghe et al., 2010; Faguet, 2014).

Further heterogeneity analysis reveals important institutional and cultural nuances. For the sub-sample of predominantly unitary countries, the negative effect of decentralisation in the low-climate-readiness regime becomes statistically insignificant, suggesting that stronger central oversight may facilitate upward accountability and policy signalling from sub-national to national governments even when climate infrastructure is limited (Rodden, 2006; Treisman, 2007). In contrast, in individualistic



societies the positive effect of decentralisation in high–climate-readiness regimes weakens, pointing to limited community mobilisation and weaker bottom-up accountability despite favourable institutional conditions. Conversely, in collectivist societies, decentralisation exerts a positive influence on women’s legal and economic rights even in low–climate-readiness regimes, reflecting the role of dense social networks and collective action in amplifying accountability and women’s voices (Agarwal, 2010; Kabeer, 2016).

The remaining portion of the work is structured as follows: The data and empirical specification are presented in Section 2; the diagnostic tests and average regression results are reported in Section 3; Section 4 reports the baseline results under a threshold regression framework; Section 5 states the robustness checks under the threshold regression model; and Section 6 presents the conclusion and policy implications.

## 2. Data and empirical specification

### 2.1 Data

The chosen countries are part of a worldwide sample that includes 53 developed and developing countries between 1995 and 2018. The selection of the countries and sample period is based on the frequency and reliable availability of data from multiple sources. List 1 lists the several countries that were the subject of this study, and List 2 lists the definitions and sources of each variable.

List 1. Countries selected for the study

|                        |           |                    |
|------------------------|-----------|--------------------|
| Albania                | Germany   | Poland             |
| Argentina              | Greece    | Portugal           |
| Australia              | Honduras  | Russian Federation |
| Austria                | Hungary   | Slovak Republic    |
| Belgium                | Indonesia | Slovenia           |
| Bosnia and Herzegovina | Ireland   | Spain              |
| Bulgaria               | Israel    | Sweden             |
| Canada                 | Italy     | Switzerland        |
| Chile                  | Japan     | Thailand           |
| Colombia               | Latvia    | Turkey             |

|                    |             |                |
|--------------------|-------------|----------------|
| Costa Rica         | Lithuania   | Ukraine        |
| Croatia            | Luxembourg  | United Kingdom |
| Cyprus             | Malaysia    | United States  |
| Czech Republic     | Mexico      |                |
| Denmark            | Mongolia    |                |
| Dominican Republic | Netherlands |                |
| El Salvador        | New Zealand |                |
| Estonia            | Norway      |                |
| Finland            | Paraguay    |                |
| France             | Peru        |                |

## List 2. Variables source and definitions

| Variable                            | Measure                                                                                                                  | Source                                   |
|-------------------------------------|--------------------------------------------------------------------------------------------------------------------------|------------------------------------------|
| WBL index                           | Composite legal equality score across eight domains (0–100), rescaled/inverted to 0–1 for legal discrimination           | World Development indicator, World Bank  |
| Fiscal decentralization (RAI index) | The extent to which a regional government exercises formal authority                                                     | Hooghe et al. (2016)                     |
| ND Gain index                       | Composite index capturing countries' climate readiness capacity across economic, governance, and social dimensions (0–1) | Notre Dame Global Adaptation Initiative  |
| Ecological footprint per capita     | Ecological footprint in million gha divided by total population                                                          | Global Footprint Network                 |
| Real GDP per capita                 | GDP per capita at 2015 constant prices                                                                                   | World Development Indicators, World Bank |
| Trade openness                      | Sum of exports and imports of goods and services measured as a % share of GDP                                            | World Development Indicators, World Bank |
| Democracy                           | Electoral democracy index, liberal democracy index, from low to high (0-1)                                               | Varieties of Democracy (V-Dem)           |

|                                    |                                                                         |                              |             |
|------------------------------------|-------------------------------------------------------------------------|------------------------------|-------------|
| Urbanization                       | Urban population as a percentage of total population                    | World Indicators, World Bank | Development |
| Labour force participation, female | Female labor force participation rate (% of female population ages 15+) | World Indicators, WorldBank  | Development |

### *Women's rights:*

In this study, women's legal discrimination constitutes the primary dependent variable and is measured using an inverse transformation of the Women, Business and the Law (WBL) index compiled by the World Bank<sup>1</sup>. The original WBL index captures gender-based legal differences affecting women's economic participation across eight key domains: mobility, workplace, pay, marriage, parenthood, entrepreneurship, assets, and pension. The index ranges from 0 to 100, with higher values indicating greater legal equality between women and men. For ease of interpretation in regression analysis, this study rescales and inverts the WBL score to construct a Legal Discrimination Index bounded between 0 and 1, where higher values denote greater legal discrimination against women.

Formally, the legal discrimination measure is defined as:

$$LD_j = 1 - (WBL_j / 100)$$

where  $LD_j$  represents legal discrimination in country  $j$ , and  $WBL_j$  denotes the original Women, Business and the Law score.

In addition to the overall composite index, the analysis incorporates six domain-specific sub-indicators drawn from the WBL framework to capture heterogeneity across legal dimensions, reflecting restrictions related to labor market participation, pay equity, family law, entrepreneurship, asset ownership, and retirement security. These disaggregated measures allow the study to examine which specific legal barriers drive observed outcomes beyond the aggregate effect.

The WBL data are constructed from standardized legal questionnaires completed by local legal experts and verified against statutory laws and regulations, ensuring cross-country comparability and consistency over time.

Figure 1 below, details a vivid description of the distribution of WBL index globally

---

<sup>1</sup> Please see World Bank. (2025). *Women, Business and the Law 2025 Methodology Handbook* (Manual and Guide) - for a detailed explanation

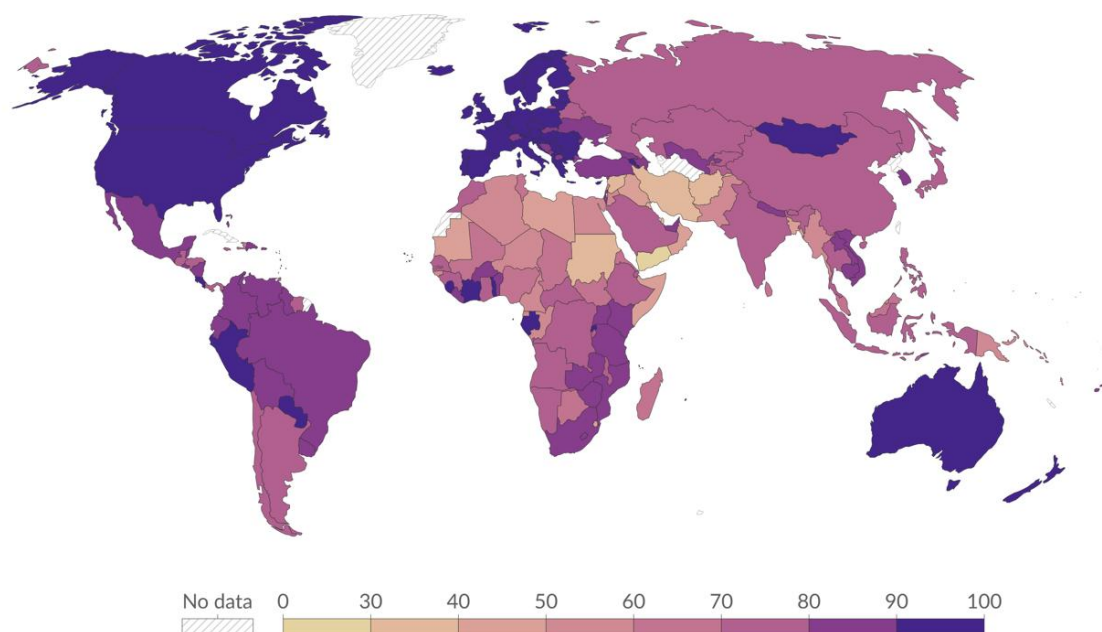
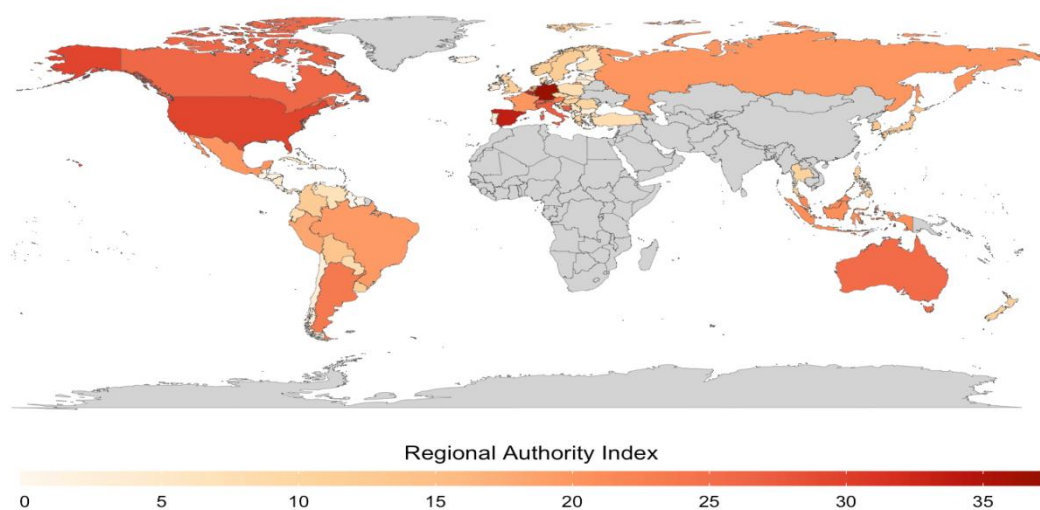


Figure 1. Distribution of WBL index across the world

Source: World Bank (2023).

#### *Fiscal decentralization:*

The regional authority index (RAI), developed by Hooghe et al. (2016), is the source of the decentralization indicator, our independent variable of interest. The regional authority index assesses how regional governments affect national politics and policy, as well as how much influence they have over the local populace. Policy scope, rule of law, fiscal autonomy, institutional depth, borrowing autonomy, borrowing control, fiscal control, executive control, and constitutional reform are the eight dimensions used to evaluate it. From 0 (least decentralized) to 38 (most decentralized), the range is covered. The regional authority index's global distribution range is shown in Figure 2 below.



**Figure 2:** Regional authority index across the world

**Source:** Hooghe et al. (2016)

### *Climate readiness:*

For our mediating variable, the Notre Dame Global Adaptation Initiative creates the ND-GAIN Climate Readiness Index<sup>2</sup>, which assesses a nation's ability to efficiently organize, draw in, and use resources for climate adaptation. The readiness component is built as a composite index that aggregates indicators from three main pillars: governance readiness, which reflects institutional effectiveness, political stability, and regulatory quality; social readiness, which includes social capacity, innovation, and education; and economic readiness, which captures the business environment and investment climate.

For instance,

Let  $j$  index countries and  $i$  index individual indicators.

Each raw indicator  $X_{ij}$  is first normalized using min–max scaling:

$$Z_{ij} = (X_{ij} - \min(X_{ij})) / (\max(X_i) - \min(X_i))$$

Indicators are grouped into three pillars: Economic (E), Governance (G), and Social (S).

Pillar scores are computed as simple averages of their constituent normalized indicators:

---

<sup>2</sup> Please see Notre Dame Global Adaptation Initiative. (2024). *ND-GAIN country index technical report*. University of Notre Dame, for detailed analysis

$$E_j = (1 / n_E) \sum_{i \in E} Z_{ij}$$

$$G_j = (1 / n_G) \sum_{i \in G} Z_{ij}$$

$$S_j = (1 / n_S) \sum_{i \in S} Z_{ij}$$

The overall Climate Readiness Index for country  $j$  is calculated as the equally weighted average of the three pillars:

$$R_j = (1/3)(E_j + G_j + S_j)$$

Higher values of  $R_j$  indicate greater institutional and socioeconomic capacity to attract, absorb, and effectively deploy climate adaptation investments. Figure 3 below highlights the pattern of climate readiness distributed globally.

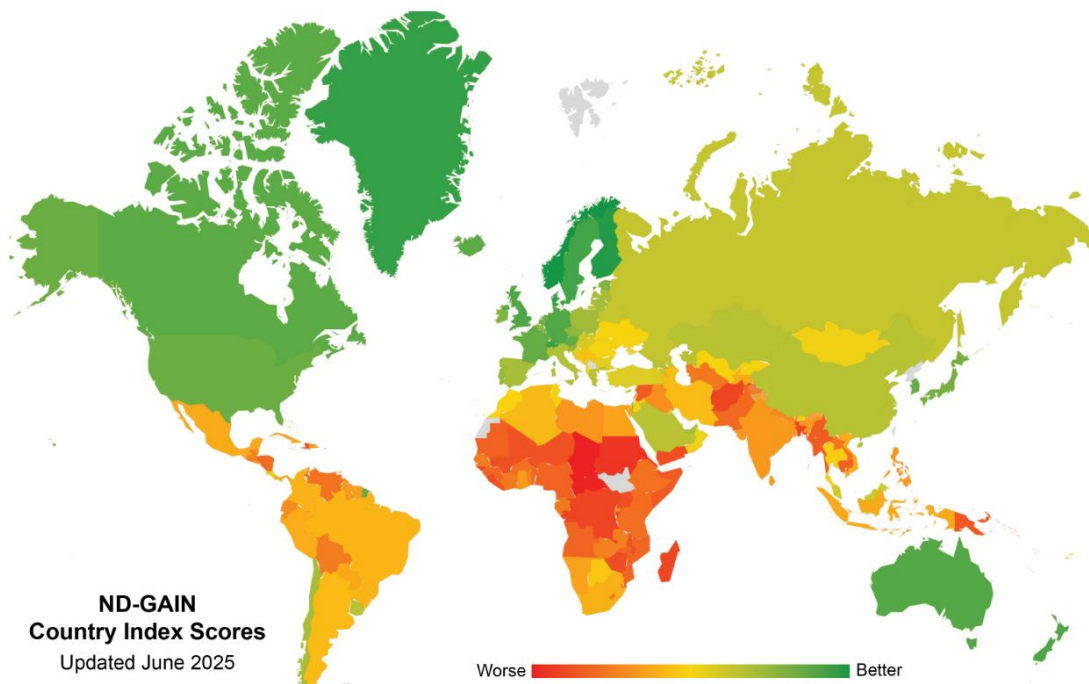


Figure 3: Distribution of climate readiness pattern across the world

Source: University of Notre Dame, 2025.

To measure democracy, one of our control variables - we use the indicators namely Electoral and Liberal Democracy, which is extracted from the Varieties of Democracy (V-Dem) Index, computed by Teorell (2022)<sup>3</sup>.

<sup>3</sup> See Teorell (2022) for a detailed description of the methodology. Data retrieved from <https://www.v-dem.net>

The electoral democracy index is founded on the idea that in an electoral democracy, the objective is to represent the core goals of the leaders chosen to hold office, which include responsiveness to the people, gained via electoral competition under conditions of universal suffrage. Political and civil society organisations are allowed to operate in such an environment, and elections are fair and free of fraud or irregularities, all of which influence the composition of the country's chief executive. This index ranges from zero (lowest) to one (highest).

Similarly, the liberal democracy index builds on electoral democracy by incorporating liberal principles such as constraints on executive authority, judicial independence, and protection of civil liberties including freedom of expression and association. It captures the extent to which elected governments operate under the rule of law with effective checks and balances. The index ranges from zero (lowest) to one (highest), with higher values indicating stronger liberal democratic institutions.

The other control variables of importance, including real GDP per capita, female labour force participation, trade openness, and urbanization are sourced from the World Development Indicator (WDI) database of the World Bank. To facilitate result interpretation, all variables have been transformed into their natural logarithmic values.

## 2.2 Empirical specification

### 2.2.1 Framework of average regression models

To analyze the influence of fiscal decentralization on women's rights, considering the mediating role of climate readiness, we estimate the model:

$$W_{it} = \alpha + \beta W_{it-1} + \Omega FD_{it} + \pi Z_{it} + \gamma (FD_{it} * Z_{it}) + \theta X_{it} + \delta_i + \epsilon_t + \mu_{it} \quad (1)$$

In Equation (1),  $W_{it}$  is the women, business, and law (WBL) index in country  $i$  and time  $t$ ,  $W_{it-1}$  is the lagged value of WBL index.  $FD_{it}$  is the indicator of decentralization measured by the regional authority index.  $\delta_i$  and  $\epsilon_t$  are the fixed effects across countries and time periods and  $\mu_{it}$  is the identically and independently distributed error term.  $X_{it}$  is the group of control variables affecting women's legal and economic rights according to extant literature. It includes labour force participation, urbanization, real per capita GDP, trade openness, and degree of democracy respectively.  $Z_{it}$  is the mediating variable, which is the indicator of climate readiness measured by the ND Gain index.  $FD_{it} * Z_{it}$  is the interaction term that would mitigate or consolidate the mechanism by which climate readiness exerts its influence on the fiscal decentralization – women's legal and economic rights nexus.

Endogeneity represents a significant challenge in fiscal federalism literature. Decentralization may itself be driven by the economic phenomena we examine, creating potential reverse causality between

decentralization and women's rights. We therefore employ the two-step system Generalized Method of Moments (GMM) estimators developed by Arellano and Bover (1995) and Blundell and Bond (1998) to address these endogeneity concerns. This estimator proves particularly suitable for our study compared to the difference GMM estimator (Arellano and Bond, 1991), as the latter exploits within-variation and is inappropriate for relatively time-invariant variables like fiscal decentralization.

Therefore, using two-way fixed effects under specification (1), we employ the system GMM estimator with heteroscedastic panels, which provides greater asymptotic efficiency than pooled OLS when series exhibit heteroscedasticity while addressing causality concerns. Given our sample's varied structure across an extended time period, heteroscedasticity among panels is likely (Wooldridge, 2010).

### *2.2.2 Framework of threshold regression models:*

While estimating Equation (1) through linear fixed effects models and system-GMM facilitates understanding of non-linearity, it does not provide a comprehensive test of linearity or identify the specific threshold level where the influence changes direction. To address these limitations, we employ an innovative GMM methodology developed by Seo and Shin (2016). This approach performs first difference transformation within the GMM (FD-GMM) framework to achieve consistent and unbiased coefficient estimation. The method ensures that estimators asymptotically follow a normal distribution while relaxing exogeneity requirements for both regressors and threshold variables. The optimal level of climate readiness which influence decentralization's working mechanism is subsequently determined, with its mathematical formulation extending Equation (1) as outlined below:

$$W_{it} = \alpha + \beta W_{it-1} + \Omega_L FD_{it} I(C_{it} \leq \xi) + \Omega_H FD_{it} I(C_{it} > \xi) + \theta X_{it} + \delta_i + \epsilon_t + \mu_{it} \quad (2)$$

Climate readiness ( $C_{it}$ ) is considered a transitional variable and fiscal decentralization is the key independent which is regime dependent in the equation above.  $\xi$  is a hypothetical value of the threshold,  $I(.)$  is a regime indicator and the lower and upper regimes across the threshold point are indicated on  $\Omega$  by the subscripts L and H, respectively. By permitting the endogeneity of the transitioning variable as well as other covariates, this model expands on the static panel threshold models developed by Hansen (1999), Caner and Hansen (2004), and Kremer et al. (2013). There is no requirement to specify a predetermined mathematical model of the nonlinearity pattern of the link between fiscal decentralization and women's rights which is one of the dynamic panel threshold model's main advantages (Kassouri, 2022).

### *2.1.2 Framework of quantile regression model across the threshold:*



Occasionally, the distribution of predictor variables may result in independent factors exerting varying effects across various regions (Bitler, 2006). We analyze the threshold implications of climate readiness on the decentralization – women’s rights nexus across the distributional range of women business and law index, considering the heterogeneities in climate infrastructure regimes and women’s rights level. This study employs the conditional panel quantile regression model developed by Machado and Santos Silva (2019). The primary advantage of this model lies in the application of dynamic estimation techniques to assess the conditional means, thereby elucidating the impact of regressors on the overall conditional pattern of the variable under consideration. Moreover, the challenges posed by unexpected parameter issues highlighted in conventional quantile regression methods are effectively resolved by the conditional mean estimation in quantile regressions with individual-specific effects (Lancaster, 2000).

The specification of the quantile model is given as:

$$Q_z(\tau|x_{it}) = (\beta_i + \alpha_i q(\tau)) + x'_{it}\delta + y'_{it}\gamma q(\tau) \quad (3)$$

In Equation (3),  $t$  denotes the  $t^{\text{th}}$  data point and  $i$  signifies the  $i^{\text{th}}$  cross-section.  $\beta_i + \alpha_i q(\tau)$  represents the distributional effect or quantile fixed effect at  $\tau$  for country  $i$ . Various segments of the conditional distribution of  $z$  may be influenced by the distributional effect. Equation (4) is then estimated with the method of moments-quantile regression (MM-QR) estimator, as per Machado and Santos Silva (2019). The moment conditions facilitate the sequential computation of the one-step GMM estimator:

- i) *Regress  $(z_{it} - \sum_t z_{it}/T)$  on  $(x_{it} - \sum_t x_{it}/T)$  by least squares to get  $\hat{\delta}$ ;*
- ii) *Estimate  $\hat{\beta} = \frac{1}{T} \sum_t z_{it} - x_{it}/\hat{\delta}$  and obtain the residuals  $\widehat{e}_{it} = z_{it} - \widehat{\beta}_{it} - x'_{it}\hat{\delta}$ ;*
- iii) *Regress  $(|\widehat{e}_{it}| - \sum_t |\widehat{e}_{it}|/T)$  on  $(y_{it} - \sum_t y_{it}/T)$  by least squares to obtain  $\hat{\gamma}$ ;*
- iv) *Estimate  $\widehat{\alpha}_i = \frac{1}{T} \sum_t |\widehat{e}_{it}| - y'_{it}\hat{\gamma}$ ;*
- v) *Estimate  $q(\tau)$  by  $\hat{q}$ , the solution to*

$$\text{Min } \sum_i^N \sum_t^T \rho_\tau(\widehat{e}_{it}) - (\widehat{\alpha}_i + y'_{it}\hat{\gamma})q$$

Where,  $\rho_{\tau}(A) = (\tau - 1)AI\{A \leq 0\} + \tau Af\{A > 0\}$  is the check function.

### 3. Diagnostic tests and average regression results

#### 3.1 Descriptive statistics and diagnostic tests

Table 1 presents the summary statistics for all variables used in this study. Preliminary diagnostic test results are provided in Tables 2 and 3, respectively.

Table 1. Summary statistics

| Variables                       | Mean      | Median  | Min    | Max        | SD        | Skewness | Kurtosis | No. of observations |
|---------------------------------|-----------|---------|--------|------------|-----------|----------|----------|---------------------|
| WBL                             | 78.5      | 80.0    | 17.5   | 100.0      | 15.5      | -1.1     | 4.7      | 1272                |
| Regional authority index        | 12.0      | 10.1    | 0.0    | 36.3       | 9.9       | 0.6      | 2.4      | 1272                |
| ND Gain                         | 56.1      | 55.7    | 32.0   | 78.3       | 10.8      | -0.1     | 2.1      | 1272                |
| Ecological footprint            | 4.79      | 4.75    | 1.03   | 10.93      | 1.99      | 0.34     | 2.75     |                     |
| Real gdp per capita             | 1990334.0 | 40819.6 | 1355.3 | 39000000.0 | 5750129.0 | 3.7      | 16.8     | 1272                |
| liberal democracy               | 0.7       | 0.8     | 0.0    | 0.9        | 0.2       | -1.1     | 3.0      | 1272                |
| electoral democracy             | 0.8       | 0.8     | 0.2    | 0.9        | 0.2       | -1.5     | 4.5      | 1272                |
| Trade openness                  | 92.7      | 80.0    | 16.4   | 360.1      | 51.0      | 1.7      | 7.6      | 1272                |
| Lab force participation, female | 43.4      | 44.7    | 30.4   | 50.8       | 4.3       | -0.7     | 2.5      | 1272                |
| Urbanization                    | 71.6      | 73.3    | 36.1   | 98.0       | 13.0      | -0.2     | 2.5      | 1272                |

Given that the sample period in this study spans over 20 years, we conduct both panel unit root and co-integration tests to ensure the consistency of the time series and to verify the existence of long-term relationships among the variables. Table 2 reports the results of Maddala and Wu's (1999) Fisher panel unit root tests. The findings indicate that most variables are stationary at level, except for real GDP per capita, trade openness, and urbanization, which exhibit stationarity after first differencing.

Table 2. Fisher's panel unit root test

| Variables                | Levels    |         | First difference |         |
|--------------------------|-----------|---------|------------------|---------|
|                          | Statistic | P value | Statistic        | P value |
| WBL                      | 122.39    | 0.00    |                  |         |
| Regional authority index | 331.05    | 0.00    |                  |         |
| Real gdp per capita      |           |         | 288.24           | 0.00    |
| liberal democracy        | 156.5     | 0.00    |                  |         |
| electoral democracy      | 133.24    | 0.00    |                  |         |
| Trade openness           |           |         | 543.38           | 0.00    |

|                                 |        |      |        |      |
|---------------------------------|--------|------|--------|------|
| Lab force participation, female | 113.86 | 0.01 |        |      |
| Urbanization                    |        |      | 125.04 | 0.00 |

Additionally, the results of Westerlund's (2007) co-integration test, which are displayed in Table 3, overall indicate a long-term correlation between ecological footprint and economic complexity.

Table 3 Westerlund Panel cointegration test

| Statistic | Value   | Z-value | P-value |
|-----------|---------|---------|---------|
| Gt        | -3.284  | -7.697  | 0       |
| Ga        | -8.666  | 2.872   | 0.998   |
| Pt        | -27.071 | -11.05  | 0       |
| Pa        | -9.942  | -1.733  | 0.042   |

### 3.2 Average regression results

It is worthwhile to first examine the relationship between fiscal decentralization and WBL index, mediated under the working mechanism of climate readiness, using traditional panel regression methods before proceeding towards the dynamic panel threshold regression model. Table 4 presents the two-step System Generalized Method of Moments (GMM) results, accounting for heteroscedasticity, endogeneity, by incorporating both country-specific and time-specific fixed effects.

Table 4: Two -step system GMM regression results

| VARIABLES                             | (1)                  | (2)                 | (3)                  | (4)                   |
|---------------------------------------|----------------------|---------------------|----------------------|-----------------------|
| Regional authority                    | -0.586***<br>(0.120) |                     |                      |                       |
| ND gain                               | -0.0910<br>(0.0778)  | 0.418***<br>(0.134) | -0.422***<br>(0.114) | -0.327***<br>(0.0883) |
| Regional authority* ND gain           | 0.138***<br>(0.0304) |                     |                      |                       |
| Expenditure decentralization          |                      | -0.0933<br>(0.166)  |                      |                       |
| Expenditure decentralization* ND gain |                      | 0.0253<br>(0.0427)  |                      |                       |
| Revenue decentralization              |                      |                     | -0.852***            |                       |

|                                                                      |          |           |          |            |
|----------------------------------------------------------------------|----------|-----------|----------|------------|
|                                                                      |          |           | (0.153)  |            |
| Revenuedecentralization*                                             |          |           | 0.218*** |            |
| ND gain                                                              |          |           |          |            |
|                                                                      |          |           | (0.0386) |            |
| Tax decentralization                                                 |          |           |          | -0.629***  |
|                                                                      |          |           |          | (0.110)    |
| Tax decentralization* ND                                             |          |           |          | 0.166***   |
| gain                                                                 |          |           |          | (0.0268)   |
| Real gdp per capita                                                  | 0.000118 | -0.0309   | -0.0239  | -0.0425*** |
|                                                                      | (0.0179) | (0.0189)  | (0.0209) | (0.0164)   |
| Urbanization                                                         | 0.206*** | 0.278***  | 0.307*** | 0.312***   |
|                                                                      | (0.0514) | (0.0613)  | (0.0583) | (0.0636)   |
| Female labour force                                                  | 0.320*** | 0.134     | 0.327*** | 0.237***   |
|                                                                      | (0.0632) | (0.0882)  | (0.0841) | (0.0635)   |
| Electoral democracy                                                  | -0.112   | -0.225*** | -0.0855  | -0.106*    |
|                                                                      | (0.0821) | (0.0625)  | (0.0772) | (0.0586)   |
| Trade openness                                                       | -0.00718 | 0.136***  | 0.127*** | 0.0479***  |
|                                                                      | (0.0127) | (0.0161)  | (0.0158) | (0.0138)   |
| Liberal democracy                                                    | 0.0687   | 0.121***  | 0.0551   | 0.0844**   |
|                                                                      | (0.0496) | (0.0382)  | (0.0462) | (0.0396)   |
| Constant                                                             | 2.550*** | 0.671     | 3.079*** | 3.375***   |
|                                                                      | (0.417)  | (0.698)   | (0.654)  | (0.565)    |
| Arellano Bond p value for                                            | 0.129    | 0.325     | 0.137    | 0.231      |
| AR(2)                                                                |          |           |          |            |
| Hansen p value                                                       | 0.342    | 0.638     | 0.429    | 0.536      |
| Country fixed effects                                                | Yes      | Yes       | Yes      | Yes        |
| Year fixed effects                                                   | Yes      | Yes       | Yes      | Yes        |
| Observations                                                         | 1272     | 571       | 599      | 860        |
| Robust Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1 |          |           |          |            |

The results presented in Columns (1) to (4) of Table 4 highlight the dual effect of fiscal decentralization: while it at the outset exacerbates women's legal and economic rights as measured by the WBL index, it also contributes to augmenting women's rights, when moderated by higher level of climate readiness infrastructure. The findings remain robust when alternative IMF-based indicators of decentralization – expenditure, revenue, and tax decentralization are used, as shown in Columns (2), (3), and (4) respectively. The validity of the model is reinforced by the Arellano-Bond test for autocorrelation and the Hansen test for instrument validity, both of which report p-values above 0.10, indicating no significant second-order autocorrelation and valid instrument specification.

The conditional character of fiscal decentralization on institutional capacity is reflected in the dual effect shown in Table 4. Since weak administrative capacity, fragmented intergovernmental coordination, and limited adaptive infrastructure increase reliance on local elites and informal power structures, decentralization initially erodes women's legal and economic rights in low-climate-readiness settings, reinforcing patriarchal norms and elite capture (Bardhan & Mookherjee, 2000; Treisman, 2007). Authority is transferred in these situations without the supplementary governance frameworks required for accountability and the protection of human rights. Stronger institutions, infrastructure investment, and vertical policy integration, on the other hand, lower capture risks and

allow decentralized governments to take advantage of information and proximity advantages as climate readiness increases. This means that decentralization can result in more gender-inclusive legal outcomes (Faguet, 2014; Ostrom, 2010). The robustness of this pattern across expenditure-, revenue-, and tax-based decentralization measures indicates that it is not fiscal autonomy alone, but the surrounding climate-governance environment, that determines whether decentralization exacerbates or alleviates women's legal and economic disadvantage.

#### 4. Dynamic panel threshold (DPT) model results.

The dynamic panel threshold regression model in Table 5 confirms the existence of a non-linear relationship between fiscal decentralization and women's legal and economics rights by identifying a threshold at the climate readiness index level of 46.9.

Table 5. Baseline DPT model

| Variables           | Lower regime | Higher regime |
|---------------------|--------------|---------------|
| Lag. WBL            | -0.1062      | 0.9003**      |
|                     | 0.3012       | 0.4462        |
| Regional authority  | -0.1831**    | 1.4805***     |
|                     | 0.0806       | 0.5034        |
| Trade openness      | -0.0551      | 0.3710*       |
|                     | 0.0777       | 0.2203        |
| Urbanization        | 0.5768       | 1.2263        |
|                     | 0.8760       | 1.5596        |
| female labour force | 0.8465       | 0.0497        |
|                     | 0.7631       | 1.2657        |
| Electoral democracy | 0.7863*      | -2.7398**     |
|                     | 0.6759       | 1.2475        |
| Liberal democracy   | -0.2084      | 1.7739*       |
|                     | 0.4181       | 1.1518        |
| Real gdp per capita | -0.1633      | 0.0091        |
|                     | 0.1495       | 0.2502        |
| Constant            | -14.5033*    |               |
|                     | 11.3060      |               |
| Threshold           | 46.9900***   |               |
|                     | 0.3383       |               |

Robust Standard errors in parentheses \*\*\* p<0.01, \*\* p<0.05, \* p<0.1

The results indicate that when fiscal decentralization is at or below a moderately higher level - specifically within an index value of 46.9, its impact on WBL index is negative and statistically significant, suggesting that decentralization in countries with lower levels of climate readiness infrastructure exacerbates environmental degradation. This threshold encompasses approximately 45% of the total sample observations below it. However, once this climate readiness threshold is

exceeded, the relationship becomes significantly positive, indicating localized benefit of decentralization on women's rights. Since all variables are expressed in natural logarithms, the coefficients can be interpreted as elasticities. Column (1) of Table 5 shows that a 1% increase in decentralization leads to a 0.18% decrease in level of WBL index below the threshold. Similarly, Column (2) reveals that, above the threshold, a 1% rise in fiscal decentralization corresponds to a 1.5% increase in the WBL index.

The net effect of fiscal decentralization on women's economic and legal rights is derived by combining the coefficient estimates for the low and high climate readiness regimes ( $-0.1831 + 1.4805 = 1.2974$ ). The significant threshold effect in the model confirms that the estimated climate readiness index value serves as a critical dividing point in the fiscal decentralization – women's rights nexus.

The second-generation fiscal federalism arguments that decentralization can exacerbate distributive consequences when devolved authority is not accompanied by administrative competence and accountability are supported by the identified climate-readiness threshold. Below the threshold, local patriarchal norms and elite capture are exacerbated by weak adaptive infrastructure, lax regulatory enforcement, and disjointed intergovernmental coordination. As a result, decentralized resources are absorbed by dominant groups instead of being translated into gender-inclusive legal reforms (Pranab Bardhan & Dilip Mookherjee, 2000; Daniel Treisman, 2007). Decentralization transfers power downward in these low-climate-readiness settings without corresponding institutional protections, which explains the negative elasticity seen below the 46.9 threshold, where fiscal autonomy strengthens structural limitations on women's economic and legal rights.

Above the threshold, however, greater climate readiness is a result of improved infrastructure investment, vertical policy integration, and governance ability, all of which reduce capture risks and allow subnational governments to take advantage of proximity and informational advantages. In line with first-generation decentralization theories that emphasize accountability and group action, this enables decentralized systems to foster inclusive legal outcomes and become more responsive to local demands (Jean-Paul Faguet, 2014; Elinor Ostrom, 2010). Climate readiness thus serves as a crucial institutional prerequisite, as evidenced by the positive elasticity calculated in the high-readiness regime. Once adaptive capacity is adequately established, fiscal decentralization stops escalating inequality and instead supports the legal and economic empowerment of women. The significant threshold effect thus confirms that it is not decentralization per se, but its interaction with climate-governance maturity, that determines the direction and magnitude of impacts on women's rights.

## **5. Robustness checks**

### 5.1 Alternative economic technique to deal with asymmetry

Table 6. Method of Moments Quantile regression model across the threshold:

| Variables           | Lower regime |            |            | Higher regime |            |            |
|---------------------|--------------|------------|------------|---------------|------------|------------|
|                     | 0.25         | 0.5        | 0.75       | 0.25          | 0.5        | 0.75       |
| Regional authority  | -0.0011      | -0.0048*** | -0.0079*** | 0.0025        | 0.0045**   | 0.0072**   |
|                     | 0.0019       | 0.0017     | 0.0021     | 0.0017        | 0.0021     | 0.0032     |
| Real gdp percapita  | -0.0308      | -0.0364    | -0.0413*   | -0.1028***    | -0.1134*** | -0.1274*** |
|                     | 0.0342       | 0.0268     | 0.0239     | 0.0285        | 0.0305     | 0.0373     |
| Trade openness      | 0.0022       | 0.0026     | 0.0030     | 0.1245***     | 0.0531     | -0.0415    |
|                     | 0.0263       | 0.0201     | 0.0179     | 0.0383        | 0.0380     | 0.0390     |
| Urbanization        | 0.2265***    | 0.2245     | 0.2228***  | 1.4526***     | 1.0643***  | 0.5491**   |
|                     | 0.0880       | 0.0721     | 0.0728     | 0.1989        | 0.2092     | 0.2364     |
| Female labour force | 0.2080*      | 0.0561*    | 0.2980***  | 0.4725*       | 0.4843     | 0.4999     |
|                     | 0.1178       | 0.0986     | 0.1029     | 0.2532        | 0.3149     | 0.4416     |
| Electoral democracy | -0.0759      | -0.0115    | 0.0446     | -0.5646**     | -0.4352*   | -0.2635    |
|                     | 0.1871       | 0.1384     | 0.1087     | 0.2657        | 0.2450     | 0.2632     |
| Liberal democracy   | 0.0597       | 0.0834*    | -0.0082    | 0.5556***     | 0.4684**   | 0.3526*    |
|                     | 0.1025       | 0.0768     | 0.0628     | 0.1933        | 0.1839     | 0.2012     |
| Constant            | 2.8842***    | 2.8307     | 2.7842***  | -3.0152**     | -0.9302    | 1.8366     |
|                     | 0.6121       | 0.5217     | 0.5447     | 1.5754        | 1.9440     | 2.6531     |

Robust Standard errors in parentheses \*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Table 6 employs a quantile regression approach to analyze how the impact of fiscal decentralization on women's economic and legal rights varies across different quantiles of the WBL index distribution. The model distinguishes between two regimes: the lower regime (countries below the climate readiness threshold) and the higher regime (countries above the climate readiness threshold). Unlike traditional mean regression, quantile regression allows for a more nuanced understanding by capturing heterogeneity in the effects of decentralization across countries with low, medium, and high levels of WBL index, reflecting the diversity in women's rights outcomes.

In the lower regime (columns 1, 2 and 3), fiscal decentralization has a overall negative and significant effect on WBL index, indicating that in countries with low ecological footprints, increasing complexity exacerbates women's legal and economic rights. In contrast, decentralization has a overall positive and significant effect on WBL index in the higher regime countries (columns 4, 5, and 6). This suggests that complexity fosters sustainability by enabling the adoption of cleaner technologies and more efficient production methods. The results thus indicate that fiscal decentralization only yields gender-inclusive gains when accompanied by climate readiness, emphasizing the importance of institutional capacity in realising women's legal and economic outcomes.

Thus, the main takeaway from the baseline DPT regression model stays consistent even after accounting for heterogeneity in the distribution of WBL index

## 5.2 Alternative indicator of fiscal decentralization

It is undeniable that the IMF-GFS indicator of decentralization remains the most widely used indicator of decentralization in the body of existing literature, accurately depicting the obligations and liabilities of a state's local governance through the devolution of spending, even though the regional authority index indicator is thought to be a relatively more composite measure of decentralization in comparison to the traditional IMF-GFS indicator (Martínez-Vázquez et al., 2017). In comparison to the regional authority index, it also encompasses a greater number of nations. The index of expenditure decentralization, or the ratio of subnational spending to general government spending, is the explanatory variable of relevance in the dynamic threshold regression model shown in Table 7.

Table 7. Robustness check : DPT model – alternate indicator of fiscal decentralization

| Variables           | Lower regime | Higher regime |
|---------------------|--------------|---------------|
| Lag. WBL            | -0.1062***   | 0.9003        |
|                     | 0.3012       | 0.4462        |
| Regional authority  | -0.1831      | 1.4805**      |
|                     | 0.0806       | 0.5034        |
| Trade openness      | -0.0551***   | 0.3710        |
|                     | 0.0777       | 0.2203        |
| Urbanization        | 0.5768       | 1.2263***     |
|                     | 0.8760       | 1.5596        |
| female labour force | 0.8465       | 0.0497**      |
|                     | 0.7631       | 1.2657        |
| Electoral democracy | 0.7863       | -2.7398       |
|                     | 0.6759       | 1.2475        |
| Liberal democracy   | -0.2084      | 1.7739*       |
|                     | 0.4181       | 1.1518        |



|                     |           |          |
|---------------------|-----------|----------|
| Real gdp per capita | -0.1633** | 0.0091** |
|                     | 0.1495    | 0.2502   |
| Constant            | -14.5033  |          |
|                     | 11.3060   |          |
| Threshold           | 46.24***  |          |
|                     | 0.3383    |          |

---

Robust Standard errors in parentheses \*\*\* p<0.01, \*\* p<0.05, \* p<0.1

---

This robustness section is thus strengthened by the results in Table 7, which corroborate the baseline model's main finding.

### 5.3 Alternate indicator of climate change: Ecological footprint

Since the ND Gain index of climate readiness is a relatively new database, to ensure robustness of our results we employ an alternate indicator of climate change vulnerability – ecological footprint, as our threshold variable. Most literature on climate change have used CO<sub>2</sub> as a proxy measure, which has lately been critiqued as an incomplete indicator and has come under scrutiny because it overlooks how each person's actions affect the environment (Zahra and Badeeb, 2022). In order to address both the harm brought about by human activity on the ground and the harm brought about by the unsolicited use of all of the natural assets on earth, our study makes use of the concept of ecological footprint, which combines these two ideas. Expressed in hectares with a worldwide production that is equivalent, the ecological footprint, which tracks anthropogenic impact on the ecology in the form of soil, air, and water, is in fact the most thorough tool and a superior measure of environmental deterioration (Dogan et al., 2019; Zahra et al., 2021).

Ecological footprint is defined as “the quantity of biologically productive land and water required to supply all resources for consumption and waste assimilation, utilizing current resource management strategies”. It is derived from data provided by the Global Footprint Network and is quantified in global hectares (gha). A temporal analysis of ecological footprint trends is presented below.:

$$EF_{ij} = \sum \frac{P_{ij}}{Y_{ij}} * YF_{ij} * IYF_{ij} * EQF_{ij}.$$

$EF_{ij}$  represents the country-specific ecological footprint for product  $i$  in year  $j$ , comprising the harvested product amount ( $P_{ij}$ ), the global average product-specific yield ( $Y_{ij}$ ), the Yield Factor ( $YF_{ij}$ ), the Intertemporal Yield Factor ( $IYF_{ij}$ )<sup>4</sup>, and the Equivalence Factor ( $EQF_{ij}$ )<sup>5</sup>. The components

---

<sup>4</sup> For a thorough description of how to calculate the Yield Factor and Intertemporal Yield Factor, see Borucke et al. (2013).

of the overall ecological footprint are agricultural footprint, grazing footprint, fisheries footprint, forest footprint, CO<sub>2</sub> footprint, and infrastructure footprint. Consequently, an increased ecological footprint correlates with heightened anthropogenic pressure on the ecosystem, and vice versa. Hence following our baseline results, a favourable working mechanism of fiscal decentralization on women's rights is expected across the lower regime countries and vice versa.

Table 8. DPT model: Alternate indicator of environmental quality

| Variables                         | Lower regime | Higher regime |
|-----------------------------------|--------------|---------------|
| Lag WBL                           | -0.8075***   | 0.1337**      |
|                                   | 0.1783       | 0.0703        |
| Regional Authority Index          | 0.5712***    | -0.5839**     |
|                                   | 0.1910       | 0.2375        |
| Real GDP per capita               | -0.5021***   | 0.0242        |
|                                   | 0.1321       | 0.1346        |
| Female labour force participation | -0.1207      | 0.1595        |
|                                   | 0.0943       | 0.1404        |
| Trade openness                    | 0.2688**     | -0.0711       |
|                                   | 0.1166       | 0.0689        |
| Urbanization                      | 0.1041       | 0.2309*       |
|                                   | 0.1577       | 0.1841        |
| Electoral democracy               | 0.0443**     | 1.0523***     |
|                                   | 0.0228       | 0.1797        |
| Liberal democracy                 | -0.0281      | 1.6824*       |

<sup>5</sup> According to Borucke et al. (2013), "Equivalence factors (EQFs) convert the areas of different land use types, at their respective world average productivities, into their equivalent areas at global average bioproductivity across all land use types".

---

|           |        |        |
|-----------|--------|--------|
|           | 0.0856 | 0.6232 |
| Constant  | 0.7473 |        |
|           | 1.1472 |        |
| Threshold | 6.4*** |        |
|           | 0.2332 |        |

---

The results in Table 8, reveals the same takeaway from the baseline threshold results. Beyond the threshold level of 6.4 (which is slight above the mean level of footprint), the impact of fiscal decentralization on women's legal and economic rights becomes unfavourable as evident from the statistically significant negative coefficient of decentralization in Column (2). Higher regime countries have higher level of footprints implying a larger strain on the environment and thereby low climate change readiness with greater risk of climate vulnerability exposure, hence crowding out the favourable impact of decentralization on women's rights observed in lower regime countries of footprint.

#### *5.4 Accounting for geographic factors: alternate sample of EU and UK*

Table 9. DPT model : Alternate sample of EU and UK

---

| <b>Variables</b>    | <b>Lower regime</b> | <b>Higher regime</b> |
|---------------------|---------------------|----------------------|
| Lag. WBL            | -0.5450             | 1.0526*              |
|                     | 0.6175              | 0.5589               |
| Regional authority  | -0.0086**           | 0.0108**             |
|                     | 0.0036              | 0.0055               |
| Real gdp per capita | 0.3025**            | -0.2053**            |
|                     | 0.1273              | 0.0992               |
| Trade openness      | -0.4124**           | 0.6076***            |
|                     | 0.1632              | 0.1692               |
| Urbanization        | 1.4532              | 0.1941               |
|                     | 1.3604              | 1.8826               |
| female labour force | -4.1674             | 6.3099**             |
|                     | 2.7121              | 2.5270               |
| Electoral democracy | -10.4265**          | 8.9379**             |
|                     | 4.6614              | 4.5006               |
| Liberal democracy   | 9.4369**            | -8.1723**            |
|                     | 4.1114              | 4.1044               |

---

|           |            |
|-----------|------------|
| Constant  | -30.4686** |
|           | 13.2180    |
| Threshold | 44.80***   |
|           | 0.0486     |

Robust Standard errors in parentheses \*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Table 9 illustrates that, despite the relatively uniform regulatory environment in Europe, the climate of readiness in a region continues to condition the working mechanism of decentralization on the outcome of women's legal and economic rights. However, the magnitude of the unfavourable impact of decentralization of WBL index is relatively low in the lower climate readiness regime countries, as compared to the baseline model. Stronger baseline institutional quality and supranational policy harmonization, especially through the European Union Cohesion Policy, which partially restrain elite capture and rights erosion even when local adaptive capacity is limited, are probably the reasons for the lessened negative impact of decentralization in low-climate-readiness European regions (Pranab Bardhan & Dilip Mookherjee, 2000; Daniel Treisman, 2007; Jean-Paul Faguet, 2014).

This raises a pertinent question: Does climate readiness level continue to play a significant role in mitigating the unfavourable effects of decentralization on women's rights, even in highly regulated settings like the European Union? To add further completeness to the explanation we account for institutional and constitutional structure in our model in the next sub-section, by examining a sample of countries which has a unitary style of government and assignment of functional powers.

### *5.5 Accounting for political and constitutional factors: alternate sample of countries with unitary federal structure*

Table 10. DPT model: countries with Unitary form of political structure

| <b>Variables</b>    | <b>Lower regime</b> | <b>Higher regime</b> |
|---------------------|---------------------|----------------------|
| Lag. WBL            | 0.18609             | 0.15759              |
|                     | 0.21836             | 0.43213              |
| Regional authority  | -0.00695            | 0.22392**            |
|                     | 0.00531             | 0.12781              |
| Real gdp per capita | 0.00458             | 0.06748*             |
|                     | 0.24285             | 0.06742              |
| Trade openness      | 0.08459             | 0.06281              |
|                     | 0.12002             | 0.12184              |
| Urbanization        | -0.21968            | 0.01886              |
|                     | 1.42285             | 0.42540              |
| female labour       | 2.34343***          | -1.08646*            |

|                        |         |          |
|------------------------|---------|----------|
| force                  |         |          |
|                        | 0.83601 | 1.01480  |
| Electoral<br>democracy | 0.31195 | -1.54550 |
|                        | 1.61194 | 1.62188  |
| Liberal<br>democracy   | 0.40034 | -0.05432 |
|                        | 1.00045 | 1.06762  |
| Constant               | 1.59286 |          |
|                        | 5.91881 |          |
| Threshold              | 55.9*** |          |
|                        | 0.01705 |          |

Robust Standard errors in parentheses \*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Table 10 confirms that the results are roughly consistent with the main takeaway from our baseline DPT model, with the unfavourable impact of fiscal decentralization on lower climate readiness regime countries becoming statistically insignificant.

The disappearance of the adverse decentralization effect in unitary systems likely reflects stronger central oversight and vertical policy coordination, which constrain local discretion and elite capture even in low-climate-readiness contexts, thereby weakening the inequality-amplifying channels emphasized by Treisman (2007); consistent with Faguet (2014), centralized institutional frameworks can partially substitute for weak subnational capacity by preserving accountability and policy coherence, rendering decentralization less harmful to women's legal and economic rights when climate readiness is low.

#### *5.6. Accounting for socio - cultural factors – Individualistic regions versus collectivist regions*

In order to take into consideration, the underlying cultural diversity that could influence the relationship between decentralization and women's rights, we use Geert Hofstede's<sup>6</sup> cultural dimensions to categorize nations as either individualistic or collectivist. Cultural norms have a significant impact on gender roles, political engagement, and law enforcement, which in turn affects how institutional improvements affect the legal and economic outcomes for women. According to Geert Hofstede (2001) and Naila Kabeer (2016), collectivism describes societies where people are enmeshed in strong in-groups that place an emphasis on social obligation, conformity, and collective identity, while individualism describes societies where social ties are relatively loose and people are expected to prioritize personal autonomy and self-determination. Thus, this cultural stratification

<sup>6</sup> See Hofstede, G. (2001). *Culture's consequences: Comparing values, behaviors, institutions and organizations across nations*, for detailed description

enables us to investigate whether the effects of fiscal decentralization differ systematically in essentially disparate social situations.

The cultural classification is drawn from Hofstede's country-level Individualism–Collectivism Index, which provides a standardized measure of societal orientation based on extensive cross-national survey data.

Table 11. DPT model: Individualistic countries versus collectivist countries

| Variables           | Individualistic countries |                       | Collectivist countries |                  |
|---------------------|---------------------------|-----------------------|------------------------|------------------|
|                     | Lower regime              | Higher regime         | Lower regime           | Higher regime    |
| Lag. WBL            | 0.645***<br>0.063         | -3.190<br>2.579       | 0.453***<br>0.122      | 0.052<br>0.779   |
| Regional authority  | -0.780***<br>0.222        | 2.328<br>1.565        | 0.269***<br>0.090      | -0.017<br>0.071  |
| Real gdp per capita | 0.001**<br>0.000          | 0.000**<br>0.000      | 0.034<br>0.099         | 0.087<br>0.147   |
| Trade openness      | 0.070***<br>0.013         | -0.268<br>0.605       | 0.073<br>0.213         | 0.186<br>0.879   |
| female labour force | 3.506***<br>0.894         | 1.693<br>5.373        | -1.124<br>1.656        | 2.613<br>3.825   |
| Urbanization        | -1.113<br>1.216           | 40.140<br>21.895      | 4.036**<br>2.457       | -6.018*<br>6.708 |
| Electoral democracy | 38.017*<br>22.241         | -1346.074<br>1660.844 | 0.462<br>1.170         | 0.636<br>2.959   |
| Liberal democracy   | -13.958*<br>24.019        | 1790.002<br>1110.587  | -0.492<br>0.811        | -0.424<br>2.221  |
| Constant            | -35.615<br>24.30          |                       | -1.005<br>4.465        |                  |
| Threshold           | 56.566***<br>0.017        |                       | 67.9***<br>0.175       |                  |

Robust Standard errors in parentheses \*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Table 11 shows that in individualistic societies the positive effect of decentralization in high–climate-readiness regime becomes statistically insignificant, suggesting that weaker community embeddedness limits collective mobilisation and bottom-up accountability even under favourable institutional conditions. By contrast, in collectivist societies the negative effect of decentralization in low–climate-readiness regime disappears, indicating that dense social networks and collective action

mechanisms can partially substitute for weak formal capacity by amplifying accountability and women's political voice (Bina Agarwal, 2010; Naila Kabeer, 2016).

Thus, summing up the robustness exercises confirm that the baseline results hold across alternative indicators, methods, and geographic and political sub-samples. However, the cultural stratification reveals deeper understanding in transmission mechanisms: collectivist contexts partly compensate for weak formal capacity through collective action, while individualistic settings show weaker mobilisation even under favourable institutions, underscoring that culture fundamentally shapes how fiscal decentralization affects women's legal and economic rights.

## **6. Conclusion and policy implications**

This study is driven by a critical gap in the empirical literature: whereas fiscal decentralization has been extensively studied in connection with governance and development outcomes, its gendered implications remain largely unexplored, especially in interaction with climate readiness. Existing research generally overlooks how climate change adaptive capability conditions the distributive impacts of decentralization and sees it as institutionally neutral. Furthermore, women's legal and economic rights are rarely analyzed in a comprehensive framework that concurrently takes sociopolitical heterogeneity, climatic readiness, and subnational fiscal power into consideration. Our study fills this knowledge gap by adding a nuanced understanding of how decentralized governance structures intersect with environmental readiness to shape gender-equitable development.

To test our hypothesis, we employ a balanced panel of 53 developed and developing countries and utilize novel indicators capturing women's economic and legal discrimination (derived from the World Bank's Women, Business and the Law framework), climate readiness (from the University of Notre Dame Global Adaptation Initiative index), and fiscal decentralization (using both regional authority and IMF-based measures). Methodologically, we combine two step system GMM estimation with interaction models, a dynamic panel threshold regression framework, and combine the same with conditional quantile regressions. This multifaceted approach allows us to capture nonlinearities, distributional heterogeneity, and causal dynamics in the decentralization–women's rights nexus.

Our results consistently show a conditional relationship between women's economic and legal rights and fiscal decentralization. Decentralization initially makes women's discrimination worse in nations with poor climate preparedness, but it significantly enhances women's rights outcomes in regions with higher level of climate change readiness infrastructure. According to the dynamic panel threshold model, decentralization becomes significantly more rights-enhancing after a threshold point in climate readiness. Quantile regressions also show that these effects remain consistent across varying points of

distribution of the WBL index in our sample, with gains concentrating in nations with greater preparation. The baseline results hold true for different decentralization and climate change metrics, econometric parameters, and political and geographic subsamples. Another layer is added by cultural stratification: collectivist societies partially offset weak formal capacity through social embeddedness, whereas individualistic contexts exhibit weaker community mobilisation even under favorable institutional conditions.

These results highlight that decentralization is not inherently empowering or regressive; rather, its impact depends fundamentally on complementary institutional and infrastructural capacity. Where climate readiness is limited, weak accountability mechanisms and elite capture undermine the potential benefits of devolved authority. Conversely, when adaptive infrastructure and governance systems are sufficiently developed, decentralization facilitates localized policy responsiveness and improves women's access to legal and economic rights. Cultural norms further mediate these dynamics by shaping collective action and bottom-up accountability, underscoring that formal institutional reforms alone are insufficient without supportive social structures.

The ramifications for policy are clear. First, if decentralization reforms are to provide equitable results, they must be implemented in tandem with investments in climate readiness, namely in institutional capacity, service delivery infrastructure, and adaptive governance. In low-readiness environments, treating decentralization as a stand-alone reform runs the danger of escalating already-existing gender disparities. Second, subnational fiscal frameworks should incorporate gender-responsive climate adaptation, ensuring that devolved resources explicitly support women's legal empowerment and economic participation. In order to harmonize standards and reduce subnational discrepancies, regional coordinating mechanisms—such as the EU adaptation framework, can play a crucial role.

Finally, the findings of the cultural dimension in our model indicate that policy design must be contextually aware. In collectivist contexts, community networks can increase the benefits of decentralization, whereas in more individualistic societies, more formal accountability channels are required to compensate for weaker social mobilization. Taken together, the research suggests an integrated policy agenda that combines fiscal decentralization, climate adaptation, and gender equality efforts. This study presents a roadmap for linking decentralization initiatives with sustainable and gender-equitable development goals by illustrating the importance of climate readiness as an enabling condition.



## References

- Agarwal, B. (2010). *Gender and green governance: The political economy of women's presence within and beyond community forestry*. Oxford University Press.
- Alston, M. (2013). Women and adaptation. *WIREs Climate Change*, 4(5), 351–358.
- Bardhan, P., & Mookherjee, D. (2000). Capture and governance at local and national levels. *American Economic Review*, 90(2), 135–139. <https://doi.org/10.1257/aer.90.2.135>
- Bardhan, P., & Mookherjee, D. (2000). Decentralizing antipoverty program delivery in developing countries. *Journal of Public Economics*, 89(4), 675–704.
- Bardhan, P., & Mookherjee, D. (2006). *Decentralization and local governance in developing countries: A comparative perspective*. MIT Press.
- Besley, T., & Coate, S. (2003). Centralized versus decentralized provision of local public goods: A political economy approach. *Journal of Public Economics*, 87(12), 2611–2637. [https://doi.org/10.1016/S0047-2727\(02\)00141-X](https://doi.org/10.1016/S0047-2727(02)00141-X)
- Borucke, M., Moore, D., Cranston, G., Gracey, K., Iha, K., Larson, J., & Galli, A. (2013). Accounting for demand and supply of the biosphere's regenerative capacity: The National Footprint Accounts' underlying methodology and framework. *Ecological indicators*, 24, 518–533.
- Bulkeley, H., & Betsill, M. (2005). Rethinking sustainable cities: Multilevel governance and the “urban” politics of climate change. *Environmental Politics*, 14(1), 42–63.
- Chen, C., Noble, I., Hellmann, J., Coffee, J., Murillo, M., & Chawla, N. (2015). *ND-GAIN Country Index*. University of Notre Dame.
- Dogan, E., Taspinar, N., & Gokmenoglu, K. K. (2019). Determinants of ecological footprint in MINT countries. *Energy & Environment*, 30(6), 1065–1086.
- Duflo, E. (2012). Women empowerment and economic development. *Journal of Economic Literature*, 50(4), 1051–1079. <https://doi.org/10.1257/jel.50.4.1051>
- Ergas, C., & York, R. (2012). Women's status and carbon emissions. *Social Science Research*, 41(4), 965–976.
- European Union. (2014). *Investment for jobs and growth: Promoting development and good governance in EU regions and cities (Sixth report on economic, social and territorial cohesion)*. Publications Office of the European Union.

Faguet, J.-P. (2014). Decentralization and governance. *World Development*, 53, 2–13. <https://doi.org/10.1016/j.worlddev.2013.01.002>

Hooghe, L., Marks, G., & Schakel, A. H. (2010). *The rise of regional authority: A comparative study of 42 democracies*. Routledge.

Kabeer, N. (2016). Gender equality, economic growth, and women's agency: The "endless variety" and "monotonous similarity" of patriarchal constraints. *World Development*, 84, 295–321.

Martinez-Vazquez, J., Lago-Peñas, S., & Sacchi, A. (2017). The impact of fiscal decentralization: A survey. *Journal of Economic Surveys*, 31(4), 1095–1129. <https://doi.org/10.1111/joes.12182>

Musgrave, R. A. (1959). *The theory of public finance: A study in public economy*. McGraw-Hill.

Oates, W. E. (1972). *Fiscal federalism*. Harcourt Brace Jovanovich.

Ostrom, E. (2010). Beyond markets and states: Polycentric governance of complex economic systems. *American Economic Review*, 100(3), 641–672.

Prud'homme, R. (1995). The dangers of decentralization. *World Bank Research Observer*, 10(2), 201–220.

Rodden, J. (2004). Comparative federalism and decentralization: On meaning and measurement. *Comparative Politics*, 36(4), 481–500.

Rodden, J. (2006). *Hamilton's paradox: The promise and peril of fiscal federalism*. Cambridge University Press.

Treisman, D. (2007). *The architecture of government: Rethinking political decentralization*. Cambridge University Press.

UNDP. (2016). *Gender and climate change: Integrating gender into climate action*. United Nations Development Programme.

World Bank. (2023). *Women, business and the law 2023*. World Bank Publications.