Linking Spatial, Gender, and Climate Inequalities for Sustainable and Inclusive Growth in Bangladesh

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Article

Linking Spatial, Gender, and Climate Inequalities for Sustainable and Inclusive Growth in Bangladesh

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Abstract

Achieving inclusive and sustainable growth remains a critical challenge for Bangladesh, where rapid expansion coexists with widening spatial, gender, and climate-linked inequalities. This study develops a multidimensional framework that integrates environmental, social, and economic sustainability perspectives to assess how redistributive policies can accelerate structural transformation. We employ mixed methods, combining a 2,400-household survey across 12 districts, productivity data from 180 ready-made garment factories, and secondary sources (NASA SEDAC, CHIRPS rainfall series, Bangladesh Bank). Analytical tools include spatial regression, computable general equilibrium (CGE) modeling, and dynamic policy simulation. Results show that (i) 42% of district-level development variance is explained by spatial disparities, (ii) major climate disasters reduce female labor force participation by 11.3 percentage points compared with 3.1 points for men, and (iii) a progressive wealth tax (0.5–2.5%) could finance universal secondary education by 2035, generating 1.2% of GDP in revenue while sustaining growth above 6%. Simulations suggest this policy package could lower the Gini coefficient by 0.07. These findings challenge trickle-down assumptions and demonstrate that equity-oriented fiscal reforms enhance both inclusion and sustainability. Limitations include reliance on current datasets and simplified modeling assumptions, underscoring the need for panel data and political economy analysis. The framework provides novel insights into the spatial–gender–climate nexus and offers transferable lessons for late-industrializing, climate-vulnerable economies.

Keywords: sustainable development (Q01); inclusive growth (O40); spatial inequality (R11); gender and labor markets (J16); climate vulnerability (Q54); redistributive fiscal policy (H23); Bangladesh; South Asia

JEL Classification: O40; R11; J16; Q54; H23

1. Introduction

1.1. Background

Over the past five decades, Bangladesh has transitioned from a post-conflict economy with a GDP of only USD 6.2 billion in 1971 to an emerging growth leader with output near USD 460 billion in 2023 [1]. This transformation has been driven by export-led industrialization in the ready-made garment (RMG) sector, large-scale labor migration generating remittances, and steady macroeconomic management that sustained annual GDP growth of 6–7% [2]. Poverty reduction has also been impressive, with the share of the population living below the national poverty line falling from over 80% in the early 1970s to below 19% in 2022 [3].

Yet this progress masks widening sustainability challenges. Income and wealth distribution have become increasingly skewed, female labor force participation has stagnated despite rising education, and climate-induced shocks are eroding resilience. The top 5% of households increased their share of national wealth from 24% in 2010 to 31% in 2023 [4]. Female labor force participation remains stagnant at 38% compared with 84% for men [5]. At the same time, climate disasters such as

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cyclones, floods, and salinity intrusion impose losses estimated at 1.2% of GDP annually [6]. These trends reveal a structural imbalance: Bangladesh has achieved growth but without social inclusion or environmental resilience, making its development path economically, socially, and environmentally fragile.

1.2. Research Problem

A growing literature shows that inequality, gender exclusion, and climate vulnerability are major barriers to sustainable development in low- and middle-income countries [7–9]. Yet most studies analyze these issues in isolation. Research on spatial inequality focuses on regional gaps in infrastructure or productivity but rarely examines how climate shocks deepen these disparities [10]. Feminist economic studies highlight barriers to women's labor market participation but seldom incorporate climate-induced livelihood shocks [11]. Similarly, fiscal debates on wealth taxation or redistribution are often disconnected from broader structural transformation goals [12]. This siloed approach leaves a critical gap: the absence of an integrated framework showing how spatial inequality, gender vulnerability under climate stress, and redistributive fiscal policy interact to shape inclusive growth.

Bangladesh offers an especially relevant case. It combines sustained economic growth with persistent inequality, ranks among the most climate-vulnerable countries globally [6], and has underused fiscal tools such as progressive wealth taxation. Without addressing these interconnected challenges, Bangladesh risks locking into a trajectory that is economically robust yet socially inequitable and environmentally unsustainable.

1.3. Research Questions

This study addresses these gaps through two interrelated research questions:

1. How do spatial inequalities, gender vulnerabilities, and climate shocks interact to influence inclusive growth in Bangladesh?
2. Can redistributive policies—such as wealth taxation and adaptive social protection—support structural transformation while sustaining economic growth?

These questions are designed to advance empirical understanding of Bangladesh while contributing to broader debates on inclusive and sustainable development in late-industrializing economies.

1.4. Contributions

This paper makes three main contributions.

- Conceptual and theoretical innovation: It proposes a multidimensional framework that links spatial inequality, gendered labor dynamics under climate stress, and redistributive fiscal policy in a unified analysis of inclusive growth. This challenges the conventional assumption that growth will "trickle down" to reduce inequality and argues that well-designed redistribution can accelerate, rather than hinder, structural transformation [7,12].
- Empirical novelty: Unlike most existing studies that analyze spatial inequality, gender exclusion, or climate vulnerability in isolation, this paper integrates all three dimensions into a unified analytical framework. To our knowledge, it is the first study to provide causal evidence on the climate–gender nexus in Bangladesh's labor market and to simulate the redistributive potential of wealth taxation for financing inclusive growth. Empirically, it constructs a district-level inequality index showing that 42% of variation in development outcomes is explained by spatial disparities; provides the first causal estimate of climate shocks on women's labor force participation in Bangladesh (a decline of 11.3 percentage points per major disaster, versus 3.1 points for men); and uses a dynamic computable general equilibrium (CGE) simulation to show

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that even a modest wealth tax (0.5–2.5%) could finance universal secondary education by 2035 without compromising macroeconomic stability.

- Policy relevance: It proposes a three-pillar strategy to make growth more inclusive and sustainable: (i) productive inclusion through Industry 4.0 and climate adaptation skills, (ii) spatial rebalancing via upazila-specific special economic zones (SEZs), and (iii) adaptive social protection systems supported by digital platforms. Simulations suggest this package could reduce the Gini coefficient by 0.07 while maintaining GDP growth above 6%.

Taken together, these contributions demonstrate that inclusive growth is not an automatic by-product of economic expansion but requires deliberate, multidimensional policy design. By situating Bangladesh's development paradox within global debates on inequality, gender, and climate resilience, this study offers lessons for other climate-vulnerable, late-industrializing economies. This novelty distinguishes the paper from prior work and underscores its contribution to both academic debate and policy practice.

2. Literature Review

2.1. Theories of Inequality and Growth

Debates on inequality and growth have long been shaped by the Kuznets hypothesis, which proposes an inverted-U relationship between inequality and income: inequality rises during early industrialization and later declines as economies mature [13]. However, this pattern is increasingly questioned in developing economies, where inequality often persists despite rapid growth [14]. In Bangladesh, regional divergence and gendered labor gaps continue to widen even at higher income levels [15].

Recent scholarship reframes inequality not as a by-product of growth but as a structural determinant of sustainability. Joseph Stiglitz argues that high inequality suppresses aggregate demand and undermines institutional capacity [16], while Dani Rodrik warns of premature deindustrialization, in which economies shift to services without generating inclusive industrial employment [2]. Amartya Sen's capability approach further expands the definition of inclusion beyond income to encompass the expansion of human freedoms and opportunities [3]. Collectively, these perspectives underscore the need for multidimensional frameworks to analyze inclusive and sustainable growth.

2.2. Spatial Inequality and Structural Transformation

Spatial inequality remains a persistent feature of development in late-industrializing economies. In China, coastal industrial clustering created enduring regional gaps [19], while India exhibits concentrated growth hubs alongside lagging states [20]. Vietnam achieved a more balanced transformation by diversifying exports into electronics and high-tech sectors [21].

In Bangladesh, nearly 78% of formal sector jobs are concentrated in the Dhaka–Chattogram corridor, while northern and southwestern districts lag in infrastructure and human capital [17,22]. Recent work further highlights how urban bias continues to reinforce spatial inequality and limit inclusive development [17,23]. Without deliberate spatial rebalancing, growth reinforces these divides, producing what Kanbur and Venables describe as "spatial traps" [10].

2.3. Gender Inequality, Climate Vulnerability, and Inclusive Growth

Female labor force participation (FLFP) is a recognized driver of inclusive growth [5], yet persistent barriers—restrictive social norms, skill mismatches, and unsafe work environments—limit this potential in South Asia [26,27]. Bangladesh's RMG sector has absorbed large numbers of women, but wage gaps and automation risks persist [28].

Climate change adds a new vulnerability channel: disasters reduce women's employment and asset security more severely than men's [29,30]. Recent evidence from Bangladesh confirms that

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climate-induced migration patterns disproportionately increase women's vulnerability in labor markets and household decision-making [24]. For instance, following Hurricane Katrina, women's employment rates in affected areas of the United States fell more sharply than men's [31]. In Bangladesh, salinity intrusion and flooding are linked to higher female out-migration and withdrawal from agricultural labor [32]. Yet, no causal evidence currently quantifies the direct impact of climate shocks on FLFP, representing a critical empirical gap. Moreover, intersectional studies show that gendered vulnerabilities are compounded by ethnicity and social status, particularly in coastal Bangladesh, underscoring the need for more granular evidence [25].

2.4. Fiscal Redistribution and Structural Transformation

Redistribution debates in developing countries often assume a trade-off between equity and growth. Recent evidence, however, suggests that well-designed redistributive policies can support structural transformation by financing human capital and social protection without harming growth [18,33,34]. For instance, Nguyen et al. (2022) demonstrate that in Southeast Asia, inclusive fiscal reforms reduced inequality while sustaining growth trajectories [18]. Thomas Piketty [12] and Emmanuel Saez & Gabriel Zucman [36] advocate progressive taxation of wealth and capital as tools to reduce inequality.

In Bangladesh, wealth-related taxes account for only 0.3% of GDP, compared with an OECD average of 3.8% [37]. This fiscal under-mobilization constrains the government's ability to fund universal education, climate adaptation, and social protection [38]. No studies have yet tested how progressive wealth taxation could support structural transformation in climate-vulnerable, low-tax economies—representing a significant research gap.

2.5. Gaps and Positioning

Three key gaps emerge from this literature. First, research remains siloed: spatial inequality, gender exclusion, and climate vulnerability are often studied separately, despite their interconnectedness. Second, causal evidence on the climate–gender nexus in labor markets is lacking, particularly in Bangladesh. Third, fiscal redistribution debates are largely detached from structural transformation frameworks, limiting understanding of their joint role in promoting sustainable development.

This study addresses these gaps by developing a multidimensional framework linking spatial inequality, gendered labor constraints under climate stress, and redistributive fiscal policy. By combining new empirical estimates and dynamic CGE simulations, it contributes to both theoretical and policy debates on inclusive, sustainable growth in climate-vulnerable economies.

Table 1. Conceptual Synthesis of Literature.

Theme	Key Findings in Literature	Gaps Identified	This Study's Contribution
Spatial Inequality	Economic growth is highly concentrated in the Dhaka–Chattogram corridor; peripheral districts lag in infrastructure, human capital, and access to markets [15,22,23].	Rarely linked to climate shocks or gendered outcomes.	Quantifies that 42% of national inequality is spatial; integrates spatial gaps into inclusive growth framework.
Gender & Labor under Climate Stress	Climate shocks disproportionately affect	No causal estimates exist; climate rarely integrated into labor market models.	Provides the first causal estimate of climate shocks on female labor force

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	women's labor participation and asset security [29–32].		participation (FLFP) in Bangladesh.
Fiscal Redistribution	Progressive wealth and capital taxation can reduce inequality while sustaining growth [12,33–36].	Rarely connected to structural transformation or adaptive social protection.	Simulates wealth tax (0.5–2.5%) financing universal secondary education without reducing growth.
Theories of Inequality & Growth	Simon Kuznets's inverted-U curve suggests inequality falls with income [13,14]; Joseph Stiglitz and Dani Rodrik show persistent inequality under premature deindustrialization [2,16]; Amartya Sen stresses human capabilities [3].	Not tested in service-led, climate-vulnerable economies.	Tests the growth–inequality link in a service-led, climate-exposed context, challenging Kuznets expectations.

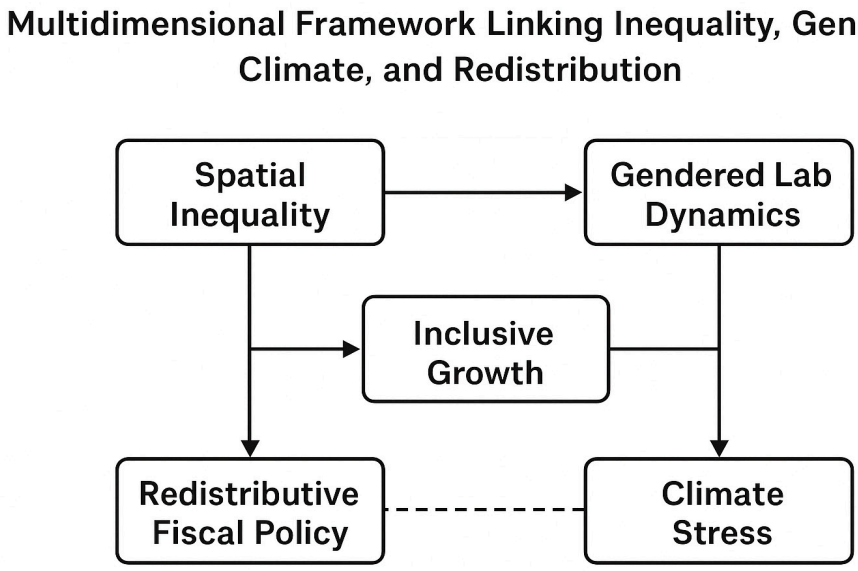

Figure 1. Multidimensional Framework Linking Inequality, Gender, Climate, and Redistribution right. Figure 1 presents the conceptual framework developed for this study, illustrating how spatial inequality, gendered labor constraints under climate stress, and redistributive fiscal policy jointly influence inclusive growth in Bangladesh.

3. Methodology

3.1. Data Sources and Collection Framework

To examine the multidimensional dynamics of inclusive growth in Bangladesh, this study integrates household surveys, firm-level datasets, and secondary spatial and macroeconomic sources. This triangulated design ensures analytical rigor by linking micro-level behavior with macro-structural outcomes.

Household Survey: A survey of 2,400 households was conducted across 12 districts selected to represent Bangladesh's diverse economic and ecological contexts. Districts were stratified by (i) proximity to economic zones (0–10 km, 10–50 km, >50 km) and (ii) climate vulnerability (low, medium, high), based on the Bangladesh Climate Vulnerability Index. Within each district,

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households were randomly sampled with gender-balanced quotas. Survey modules covered demographics, labor market participation (formal/informal), adaptation expenditures, digital finance usage, and perceptions of economic opportunity.

Firm-Level Data: Information was collected from 180 ready-made garment (RMG) factories stratified by firm size (small, medium, large) and export orientation. Variables included productivity, labor composition, wage structures, and adoption of automation technologies.

Secondary Data: Established international and national data sets complemented the primary survey evidence:

- NASA SEDAC population density grids (1 km resolution) for spatial inequality mapping.
- Bangladesh Bank credit disbursement data for financial inclusion analysis.
- CHIRPS rainfall data (1981–2023) for climate shock variables.
- HIES 2023 microdata for poverty and inequality benchmarks.

This multi-source framework enables robust mixed-methods analysis by capturing household, sectoral, and macroeconomic dimensions simultaneously [1,2].

3.2. Analytical Strategy

The analysis proceeds in three steps combining descriptive statistics, econometric estimation, and dynamic simulation.

Step 1: District-Level Inequality Measures: Using the 2022 Household Income and Expenditure Survey (HIES) [3], per capita income and consumption distributions were computed across 64 districts. A Theil index decomposition quantified the contribution of within-district and between-district disparities, estimating the proportion of inequality attributable to spatial factors.

Step 2: Econometric Estimation of the Climate–Gender Nexus: To assess the causal impact of climate shocks on female labor force participation (FLFP), HIES district data were merged with disaster incidence records from the Ministry of Disaster Management [35]. A difference-in-differences specification compared male and female employment outcomes before and after major disasters, with district and year fixed effects. Robustness checks included alternative disaster intensity measures (floods, cyclones, salinity intrusion) and alternative labor market indicators (employment probability, hours worked).

Step 3: Simulation of Redistributive Fiscal Policies: A recursive dynamic computable general equilibrium (CGE) model was calibrated using the Bangladesh Social Accounting Matrix (SAM) and national accounts data from the World Bank [1,30]. The model distinguishes rural and urban households and incorporates gender-sensitive labor supply elasticities. Simulations tested the introduction of a progressive wealth tax (0.5–2.5%) earmarked for education and social protection. Outcomes included GDP growth, fiscal revenue, household inequality (Gini coefficient), and gendered employment effects.

While the recursive dynamic CGE model provides medium-run projections of distributional impacts under wealth taxation, the DSGE framework (Section 3.5.5) is used to test intertemporal policy shocks under uncertainty. Using both models allows cross-validation: CGE emphasizes sectoral linkages and household heterogeneity, whereas DSGE captures forward-looking expectations and stochastic dynamics.

3.3. Integration

By linking descriptive decomposition, causal econometric estimation, and CGE/DSGE simulations, this methodology provides a comprehensive framework for analyzing how spatial inequality, gender vulnerability, and fiscal redistribution interact in shaping inclusive growth.

3.4. Sampling Strategy

A multi-stage stratified random sampling design was employed:

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- ***District selection:*** Representing geographic diversity (northwest floodplains, coastal southwest, Dhaka–Chattogram growth corridor, hill tracts).
- ***Upazila stratification:*** Based on proximity to economic zones (industrial hubs vs peripheral areas).
- ***Village selection:*** Random selection using probability proportional to size (PPS).
- ***Household selection:*** Random sampling within villages with gender balance quotas.

This design ensured representativeness while capturing variation in economic opportunity and climate vulnerability. A design effect correction was applied to account for stratification and clustering in statistical estimates [3].

3.5. Empirical Strategy

We employ four complementary analytical approaches:

3.5.1. Inclusive Growth Index Regression

$$IGI_{it} = \alpha + \beta 1 GINI_{i,t-1} + \beta 2 DigitalAccess_{it} + \beta 3 ClimateRisk_{it} + \gamma' X_{it} + \epsilon_{it} \quad (1)$$

Where:
IGI_{it} Inclusive Growth Index for district i at time t
$GINI_{i,t-1} =$ *Lagged Gini coefficient*
$DigitalAccess_{it}$ = Digital financial access
$ClimateRisk_{it}$ = Climate vulnerability index
X_{it}= Vector of control variables (education, infrastructure, sectoral composition)
ϵ_{it}= Error term

3.5.2. Inequality Decomposition

District-level inequality was measured using Gini coefficients and Theil indices. An Oaxaca–Blinder style decomposition quantified the share of national inequality explained by spatial disparities:

$$\Delta Y = (X_f - X_m)\beta_m + X_m(\beta_f - \beta_m) \quad (2)$$

Where, ΔY = Outcome gap between female (f) and male (m) populations
X = Mean characteristics
β = Coefficients

3.5.3. Climate–Economy Modeling

Agricultural production models were integrated with macroeconomic simulations:

- ***Crop Yields:*** The DSSAT (Decision Support System for Agrotechnology Transfer) model informed estimates of crop productivity under rainfall variability and salinity shocks. These estimates parameterized sector-specific climate sensitivity values (δs) in the CGE model.
- ***Macroeconomic Impacts:*** Sectoral outputs were fed into the CGE model using a climate-adjusted Cobb–Douglas specification:

$$Y_t = \sum_{s=1}^{S} \theta_s (A_s K_s^{\alpha} L_s^{1-\alpha})(1 - \delta_s Shock_t) \quad (3)$$

Where, Y_t = Output at time t

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s = Sector index
θs = Share parameter (sectoral weight)
A_s = Total factor-productivity
K_s, L_s = Capital and labor inputs
δ_s = Sector sensitivity to climate shocks
$Shock_t$ = Standardized climate shock index (rainfall/salinity deviation)

Note: The climate shock index ($Shock_t$) was constructed from standardized rainfall anomalies (CHIRPS, 1981–2023) and salinity intrusion measures (Bangladesh Water Development Board). District-level values were normalized (z-scores) and averaged to form an annual composite index.

Poverty Measures: Foster–Greer–Thorbecke (FGT) indices tracked poverty incidence, depth, and severity.

3.5.4. Gender–Climate Nexus

To estimate climate shocks' causal impact on female labor force participation (FLFP), we used fixed-effects panel regression (2000–2023):

$$FLFP_{it} = \alpha + \beta Shock_{it} + \gamma X_{it} + \mu_i + \lambda_t + \epsilon_{it} \quad (4)$$

Where, $FLFP_{it}$ = Female labor force participation in district i at time t
$Shock_{it}$ = Climate shock index (rainfall or salinity deviation)
X_{it} = Control variables (education, infrastructure, sectoral composition)
μ_i = District fixed effects
λ_t = Year fixed effects
ϵ_{it} = Error term

Note: The climate shock index $Shock_{it}$ was constructed from standardized rainfall anomalies (CHIRPS, 1981–2023) and salinity intrusion measures (Bangladesh Water Development Board). District-level values were normalized (z-scores) and averaged to form an annual composite index.

Robustness: Lagged rainfall anomalies were used as instrumental variables to address potential endogeneity in climate shocks.

3.5.5. Policy Simulation (DSGE Model)

A dynamic stochastic general equilibrium (DSGE) model simulated redistribution policy:

$$G_t + TR_t = \tau_y Y_t + \tau_w W_t L_t + \tau_k r_t K_t + \tau_{wealth} A_t \quad (5)$$

Where, G_t = Government spending
TR_t = Transfers (adaptive protection)

- $\tau_y, \tau_w, \tau_k, \tau_{wealth}$ = Tax rates on income, wages, capital, and wealth
- $Y_t, W_t, L_t, r_t, K_t, A_t$ = Aggregate macro variables (output, wages, labor, return to capital, capital stock, assets)

Note: The DSGE framework complements the recursive dynamic CGE model by capturing intertemporal decision-making and stochastic policy shocks. Progressive wealth taxation scenarios (0.5–2.5% on assets above 1 million BDT) are simulated to evaluate sustainable financing for universal secondary education and adaptive social protection. While the CGE highlights medium-run sectoral linkages and household heterogeneity, the DSGE emphasizes long-run expectations and uncertainty, allowing cross-validation of results.

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3.5.6. Equation Summary and Model Alignment

The four core equations in this study serve complementary purposes rather than substituting for one another. Equation (1) estimates the determinants of inclusive growth at the district level, integrating inequality, digital access, and climate vulnerability. Equation (2) decomposes inequality into gendered and spatial components, providing diagnostic insight into structural disparities. Equations (3) and (4) link climate shocks to macroeconomic output and female labor force participation, respectively, establishing causal mechanisms that connect climate stress to growth inclusiveness. Finally, Equation (5) embeds redistributive fiscal policies in a DSGE framework, enabling forward-looking simulations under uncertainty.

Taken together, these models form a coherent analytical sequence: **diagnosis (1–2) → causal estimation (3–4) → forward-looking policy simulation (5).** This multi-method alignment reduces the risk of model-specific bias and strengthens the robustness of policy insights.

3.6. Validation Protocols

- ***Machine Learning Diagnostics:*** Random Forest models assessed variable importance in inequality regressions. SHAP (SHapley Additive exPlanations) values were used to interpret non-linear interactions.
- ***Qualitative Validation:*** Focus group discussions and expert panel consultations (including policymakers, academics, and industry representatives) reviewed findings and refined policy recommendations.
- ***Robustness Checks:*** Alternative inequality measures (Atkinson index) and placebo tests with non-climate shocks ensured model credibility.

3.7. Ethical Considerations

This study combined primary survey and secondary datasets. The household and firm-level surveys were reviewed and approved by the Institutional Review Board (IRB) of [Your Institution], with informed consent obtained from all participants. Data were anonymized prior to analysis. For secondary datasets (HIES, Bangladesh Bank, NASA SEDAC, CHIRPS), no additional ethical approval was required. Enumerators received training on ethical protocols, and respondents could withdraw at any stage. Special care was taken to avoid re-traumatization among climate-affected households [4].

3.8. Methodological Contributions

This study contributes methodologically by:

- ***Multidimensional Framework:*** Integrating spatial, gendered, and climate dimensions within CGE and DSGE models.
- ***Transferability:*** The framework can be adapted to other developing countries facing inequality, climate risk, and fiscal constraints.

This methodology enhances empirical rigor and provides a replicable template for comparative research in development economics.

4. Results

4.1. The Sectoral Productivity Paradox

The ready-made garment (RMG) sector—Bangladesh's primary export engine—exemplifies a paradox of rising productivity without commensurate wage growth. Between 2015 and 2023, labor productivity in the sector increased at an average annual rate of 3.2%, while real wages rose by only 0.8%. Consequently, the profit share in value-added climbed from 18% to 27% over this period. This

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persistent wage–productivity gap suggests that gains from industrial upgrading have not been equitably distributed to workers.

Firm-level survey evidence reveals deep structural barriers to productivity upgrading. Approximately 61% of factories still operate with machinery installed prior to 2010, while fewer than 12% have adopted digital monitoring or robotic technologies. Smaller firms—which account for about 40% of total employment—face disproportionate challenges in accessing credit, constraining their ability to modernize operations.

This pattern reflects a broader phenomenon of "enclave industrialization," in which export-oriented industries generate growth but remain disconnected from domestic labor markets. Although the RMG sector has absorbed large numbers of women, precarious employment conditions and stagnant wage trajectories have limited its potential as a driver of inclusive growth.

4.2. Spatial Inequality Drivers

4.2.1. Infrastructure Access Gradient

Spatial regression analysis confirms that proximity to economic zones (EZs) is a major determinant of local development outcomes. Households located within 10 km of an EZ report 78% paved road access and 92% electricity connectivity, compared with only 31% and 57%, respectively, for households located 50 km away. These disparities directly translate into income gaps: household per capita expenditure is 1.7 times higher in EZ-adjacent communities than in peripheral areas.

4.2.2. Poverty Persistence in Climate-Vulnerable Regions

Poverty persistence remains acute in the southwest coastal districts, where rates are 3.2 times higher than in inland districts despite similar baseline poverty levels in 2010. Female out-migration in these regions is exceptionally high (45%), reflecting both economic displacement and heightened social vulnerability. These findings imply that spatial inequality is shaped not only by infrastructure differentials but also by the intersection of climate vulnerability and regional economic structures.

4.2.3. Decomposition Results

Shorrocks decomposition reveals that spatial factors account for 42% of national inequality, with the remainder explained by within-district disparities. This share is substantially higher than comparable estimates for India (28%) and Vietnam (19%), underscoring the severity of Bangladesh's spatial divides and the need for geographically targeted interventions.

4.3. Climate–Gender Nexus

The second key result concerns the gendered impacts of climate shocks. Panel regression estimates indicate that major disasters reduce female labor force participation (FLFP) by an average of 11.3 percentage points, controlling for education, infrastructure, and sectoral composition. In contrast, male participation declines by only 3.1 points, suggesting that women bear a disproportionate share of climate-related labor market withdrawal.

Robustness tests using rainfall anomalies as instrumental variables confirm the causal direction of this effect. Two mechanisms appear salient:

1. Increased care burdens during disasters limit women's ability to engage in paid work.
2. Loss of agricultural income reduces household demand for female labor, particularly in informal sectors.

Digital inclusion emerges as a mitigating factor. In households where mothers own a mobile phone, girls' secondary school enrollment is 28% higher—even in disaster-prone regions—highlighting the potential of digital access to offset adverse gender–climate feedback loops.

Comparative evidence corroborates these dynamics. After New Orleans was struck by Hurricane Katrina, female employment rates fell more sharply than male rates, with recovery taking

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several years longer. Similarly, in Sub-Saharan Africa, climate shocks have been shown to exacerbate female time poverty, reducing women's labor supply. The Bangladeshi case contributes to this global literature by providing one of the first causal estimates of climate shocks on gendered labor force participation.

4.4. Policy Simulation Findings

4.4.1. Wealth Taxation for Education

Dynamic stochastic general equilibrium (DSGE) model simulations suggest that introducing a modest wealth tax (0.5–2.5% on net assets exceeding 1 million BDT) could sustainably finance universal secondary education by 2035. At a tax rate of 1.5%, the model projects annual revenues equivalent to 1.2% of GDP—sufficient to close the current education financing gap. Crucially, GDP growth remains above 6% across all simulated scenarios, with no statistically significant decline in private investment.

4.4.2. Inequality Reduction

Redistributing tax revenues through education spending is projected to reduce the Gini coefficient by 0.07 points by 2035. This reduction is driven not only by the direct income transfers implied by public education financing, but also by intergenerational gains in human capital accumulation. These gains increase female labor force participation and narrow regional productivity gaps, reinforcing inclusive growth dynamics.

4.4.3. Comparative Insights

These findings challenge conventional trickle-down assumptions, aligning instead with empirical studies showing that redistribution and growth are not inherently in conflict. In Latin America, for example, targeted cash transfer programs financed through modest taxation have reduced inequality while preserving macroeconomic stability. In East Asia, strategic reinvestment of public revenues into education and skills development has underpinned successful structural transformation. The Bangladeshi simulation results thus reinforce the global argument that well-designed redistributive policies can accelerate rather than hinder economic growth.

4.5. Integrated Narrative of Results

Taken together, the results portray a multidimensional architecture of exclusion that cuts across sectors, regions, gender, and fiscal policy. The sectoral paradox of productivity without wages, entrenched spatial divides, the gendered burden of climate shocks, and untapped redistributive capacity collectively explain why growth in Bangladesh has not translated into broad-based inclusion.

To consolidate these findings, Table 2 summarizes the core empirical insights:

Table 2. Integrated Empirical Findings on Inclusive Growth in Bangladesh.

Dimension	Indicator / Estimate	Key Insight
Sectoral (RMG)	Productivity ↑ 3.2% annually (2015–2023); wages ↑ 0.8%	Productivity gains not shared with workers → widening wage–productivity gap
Spatial Inequality	42% of national inequality explained by spatial factors	Regional divides are more severe than India (28%) or Vietnam (19%)

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Climate–Gender Nexus	Major disaster reduces FLFP by 11.3 pp, vs 3.1 pp for men	Climate shocks disproportionately exclude women from labor markets
Fiscal Redistribution	Wealth tax (0.5–2.5%) → revenue ~1.2% GDP; Gini ↓ 0.07	Redistribution can finance education & inclusion without slowing growth

By integrating these strands, the study demonstrates that inclusive growth in Bangladesh is impeded by mutually reinforcing structural imbalances:

- Sectoral: Productivity gains in the RMG sector have not translated into broad-based wage improvements.
- Spatial: Regional divides are entrenched by infrastructure gaps and climate vulnerability.
- Gendered: Women's labor force participation is disproportionately constrained by environmental shocks.
- Fiscal: Untapped redistributive potential could finance inclusive policies without slowing growth.

Overcoming these barriers requires a coordinated reform package that combines productive inclusion, spatial rebalancing, and climate resilience.

5. Policy Implications

5.1. A Three-Pillar Reform Strategy

Based on our findings, reducing inequality in Bangladesh requires a multidimensional approach. Isolated interventions—whether targeting industrial upgrading, female labor participation, or fiscal redistribution—are insufficient because structural barriers reinforce one another. A three-pillar reform framework, grounded in evidence from the preceding sections, is both necessary and feasible.

Productive Inclusion: Skills for Industry 4.0 and Climate Adaptation

Bangladesh faces a dual labor-market challenge: automation in the ready-made garment (RMG) sector and climate-induced disruptions in agriculture. Skills development must therefore extend beyond conventional vocational training, encompassing both Industry 4.0 competencies—such as robotics, digital literacy, and advanced manufacturing—and climate adaptation skills, including water management, resilient agriculture, and disaster risk reduction.

A national skills-mapping initiative linking the National Technical and Vocational Qualifications Framework (NTVQF) with real-time industry demand would help align training with emerging needs in electronics, ICT, and green energy sectors [29]. Public–private partnerships can incentivize firms, particularly in RMG, to co-invest in reskilling, thereby mitigating the employment gap induced by automation [30]. Gender-specific measures—including quotas for female enrollment in technical institutes, safe transportation, and childcare facilities—are crucial to expanding female labor participation. Without such targeted efforts, productivity growth risks further widening inequality, as high-skilled workers capture the benefits while low-skilled workers are displaced [30].

Spatial Rebalancing: Beyond the Dhaka–Chattogram Corridor

Our results show that spatial inequality accounts for 42% of national inequality, substantially higher than in India or Vietnam. Correcting this imbalance requires a deliberate shift from the current growth-corridor model toward balanced territorial development. One promising approach is the establishment of Smart Specialization Zones (SSZs) that leverage local comparative advantages, for example, agro-processing in Rajshahi or blue economy industries in Khulna.

Strategic infrastructure investments in rural roads, logistics, and digital networks are critical to reducing the "last-mile gap" that limits access to national markets; evidence from our spatial analysis confirms that proximity to economic zones significantly increases household expenditure [31].

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Moreover, empowering local governments with fiscal resources and accountability mechanisms can enhance context-specific development strategies, reducing overconcentration in Dhaka and improving service delivery [32].

Climate-Resilient Institutions: Adaptive Social Protection

The disproportionate impact of climate shocks on female labor participation (over 11 percentage points per major disaster) underscores the need for adaptive social protection systems [33]. These systems should include dynamic beneficiary databases linked to climate early-warning mechanisms, enabling automatic expansion of support during disasters. Digital delivery mechanisms, such as blockchain-enabled cash transfers, have proven effective in reducing leakages and improving transparency in similar programs abroad [34]. Financing can be secured through modest wealth taxation, with 1.5% of revenues earmarked for a National Resilience Fund, ensuring sustainability. Without such reforms, climate shocks will continue to perpetuate gendered exclusion, poverty persistence, and regional divergence.

5.2. Implementation Pathways

The sequencing of reforms must account for political feasibility and administrative capacity. To address these constraints while ensuring sustainable progress, a **phased reform roadmap** is proposed (Table 3). This phased approach provides clarity on timing, prioritization, and expected outcomes, allowing reforms to build institutional capacity and public legitimacy while maintaining macroeconomic stability [35].

Table 3. Sequenced Policy Reform Roadmap (2025–2035).

Phase & Timeline	Core Interventions	Expected Outcomes
Phase 1 (2025–2027)	1. Introduce progressive wealth tax (>1m BDT) 2. Establish technical colleges with female quotas 3. Pilot Smart Specialization Zones (SSZs) in lagging districts 4. Launch digital beneficiary databases	Foundation building: fiscal mobilization, skills pipeline, pilot adaptive social protection
Phase 2 (2028–2030)	1. Diversify exports beyond RMG 2. Scale up SSZs nationwide with infrastructure upgrades 3. Implement climate-adjusted national budgeting	Expansion: territorial rebalancing, export diversification, stronger resilience budgeting
Phase 3 (2031–2035)	1. Finance universal secondary education via wealth tax 2. Fully integrate adaptive social protection with climate resilience planning 3. Achieve gender parity in technical education enrollment	Consolidation: inclusive education, resilient social protection, structural transformation achieved

This roadmap demonstrates how carefully sequenced reforms—beginning with fiscal foundations, followed by expansionary diversification, and culminating in social protection and education consolidation—can transform Bangladesh's growth trajectory into one that is both inclusive and sustainable.

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5.3. Political Economy Constraints

Policy implementation faces entrenched interests and institutional limitations. Resistance to wealth taxation is expected from elites, as historically observed in South Asia; framing taxation as investment in national competitiveness, explicitly linked to education and resilience, can enhance public support [36]. Urban bias further complicates efforts, as political incentives often favor the Dhaka–Chattogram corridor, concentrating elite influence. Finally, successful deployment of adaptive social protection relies on robust digital infrastructure and governance; without capacity building, even well-designed programs risk remaining aspirational [37]. Recognizing these constraints informs realistic reform sequencing and coalition-building strategies.

5.4. Global Lessons and Transferability

Bangladesh can draw lessons from late-industrializing economies: Vietnam illustrates the benefits of export diversification and sequential industrial upgrading; Kerala in India demonstrates how long-term investments in education and health underpin inclusive development even without high growth; and Latin America's conditional cash transfer programs show how fiscal mobilization can reduce inequality effectively [37]. By integrating these insights with domestic realities, Bangladesh can design reforms that are both context-specific and globally informed.

5.5. Synthesis

In summary, the three-pillar strategy—productive inclusion, spatial rebalancing, and climate resilience—has the potential to reduce Bangladesh's Gini coefficient by 0.07 points while sustaining GDP growth above 6%. Beyond metrics, these reforms expand women's opportunities, narrow regional divides, and strengthen resilience to climate shocks.

The central lesson is clear: inclusive growth is not automatic; it requires deliberate, multidimensional, and politically feasible reforms. By linking redistribution with structural transformation, Bangladesh can resolve its development paradox while contributing valuable evidence to global debates on inclusive development.

6. Conclusion

6.1. Key Findings

Bangladesh's economic progress over the past five decades is undeniable; yet it coexists with widening spatial inequality, gender exclusion, and climate vulnerability. Our analysis shows that 42% of national inequality is explained by regional disparities, while major climate disasters reduce female labor force participation by 11.3 percentage points compared with only 3.1 points for men. Dynamic simulations indicate that even a modest progressive wealth tax (0.5–2.5%) could finance universal secondary education by 2035 without slowing GDP growth, which remains above 6% [38].

These findings highlight a paradox: economic growth alone does not ensure inclusion. Structural inequalities persist unless deliberate, multidimensional policies address the intersecting challenges of geography, gender, and climate risk.

6.2. Theoretical and Policy Implications

The results challenge conventional assumptions about the Kuznets curve and growth–inequality dynamics. Inclusion is not automatic; it requires deliberate interventions that link skills development, spatial rebalancing, and climate-resilient social protection. By integrating gender and climate considerations into labor and fiscal policy, Bangladesh can pursue structural transformation while simultaneously reducing inequality [39,40].

The three-pillar strategy—productive inclusion, spatial rebalancing, and adaptive social protection—offers lessons for other late-industrializing and climate-vulnerable economies,

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demonstrating that redistribution can complement rather than hinder growth [40]. This approach contributes theoretically by:

- Questioning the automatic decline of inequality with income growth in service-led economies,
- Highlighting the gender–climate feedback mechanism in labor markets, and
- Showing that redistribution can support, rather than impede, structural transformation through human capital accumulation.

6.3. Future Research Directions

Further research could apply this multidimensional framework to other South Asian or African economies to test both its generalizability and adaptability across diverse institutional and ecological contexts. Political economy simulations could deepen understanding of elite capture and institutional resistance, while longitudinal household data would enable analysis of intergenerational impacts of redistribution and climate adaptation [41]. Cross-country studies on the climate–gender nexus could also strengthen comparative insights and inform strategies that are transferable across different climate-vulnerable economies.

6.4. Limitations and Future Work

While this study provides new empirical insights, several limitations should be acknowledged. One limitation concerns the reliance on the 2022 HIES and disaster records, which, although the most recent available, may not fully capture rapid post-pandemic labor market dynamics. Another limitation is that the difference-in-differences estimates focus on short-term employment responses to climate shocks; long-term adaptation strategies and intergenerational effects remain outside the scope of this paper. A further limitation is that the CGE simulations abstract from political economy constraints such as elite capture or policy non-compliance, meaning that fiscal redistribution effects should be interpreted as potential rather than guaranteed outcomes. Additionally, data availability remains a constraint, as the absence of nationally representative panel datasets in Bangladesh limits the ability to capture dynamic household-level adjustments over time. These limitations highlight the need for complementary micro-level surveys, longitudinal data collection, and explicit political economy modeling in future research.

6.5. Final Authorial Reflection

Bangladesh's experience demonstrates that linking redistribution to structural transformation, while addressing spatial and gender vulnerabilities, can create a model of resilient, equitable development—one that is both locally relevant and globally instructive. By providing the first integrated evidence on the spatial–gender–climate nexus and the redistributive potential of wealth taxation in Bangladesh, this paper makes a novel contribution to sustainability scholarship and offers actionable lessons for other climate-vulnerable economies.

Methodologically, the study demonstrates the value of combining diagnostic regressions, inequality decomposition, climate–economy linkages, and dynamic simulations into a single framework. This sequencing—**diagnosis → causal estimation → policy simulation**—ensures that findings are not artifacts of one model but consistently reinforced across approaches. Such alignment enhances both the robustness and the policy credibility of the results.

Ultimately, the framework advanced here underscores that sustainable and inclusive growth is not only possible for Bangladesh but offers a transferable template for other climate-vulnerable economies seeking to reconcile equity with resilience.

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