

Does Climate Change Affect Female Employment in South Asian Countries? The Interaction Effects of Income Inequality and Gender Inequality

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Background: Rural populations in low- and middle-income nations face significant developmental challenges due to climate change. Research indicates that increasing temperatures over recent decades have substantially reduced women's employment opportunities in South Asian countries. These communities face additional hardships from extreme weather patterns, including more frequent summer heat waves and severe winters. Projections suggest that shifts in temperature and precipitation patterns will continue to reduce women's employment prospects, particularly in India, Pakistan and Sri Lanka.

Objectives: This research examines how climate change affected women's employment in South Asian countries between 2000 and 2022. The study also analyses how income and gender disparities interact with women's employment during climate change. The analysis incorporates economic indicators to provide comprehensive insights, including foreign direct investment, government spending, mobile phone adoption and financial integration.

Data and Methods: The research utilises balanced panel data from eight South Asian countries spanning 2000-2022. Data availability determines the selection of regions, countries, and timeframes. Information was gathered from multiple sources, including World Development Indicators, Climate Change Knowledge Portal and KOF Swiss Economic Institute. The analysis employs quantile regression alongside the System Generalised Method of Moments estimation techniques.

Major Findings and Policy Implications: Our analysis reveals that temperature variations negatively impact women's employment regionally, while increased rainfall shows positive effects. Inequality persists as a major barrier to progress. Rising income disparities lead to steeper declines in women's employment across sectors, with women facing disproportionate impacts during crises. Gender inequality further expands gaps in opportunities and wage discrimination regionally. Post-pandemic gender discrimination has significantly affected economies like India, Sri Lanka and Bangladesh across various sectors. Our findings suggest that climate adaptation strategies should incorporate gender considerations to address women's specific vulnerabilities. Additionally, improvements in women's education have notably enhanced their employment opportunities and prospects.

Keywords: Climate change; Female employment; Gender inequality; Income inequality; South Asia regions; FDI

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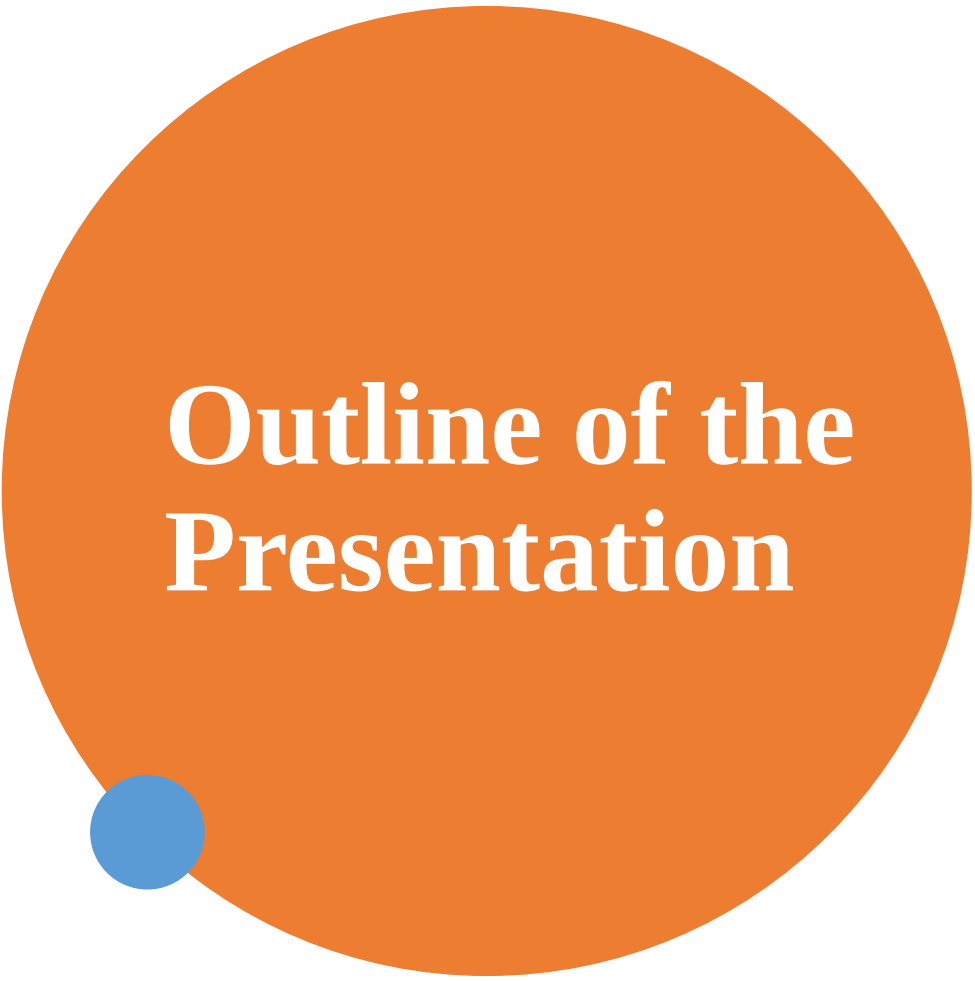
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Outline of the Presentation

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- **Review of Literature**
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- **Objectives of the Study**
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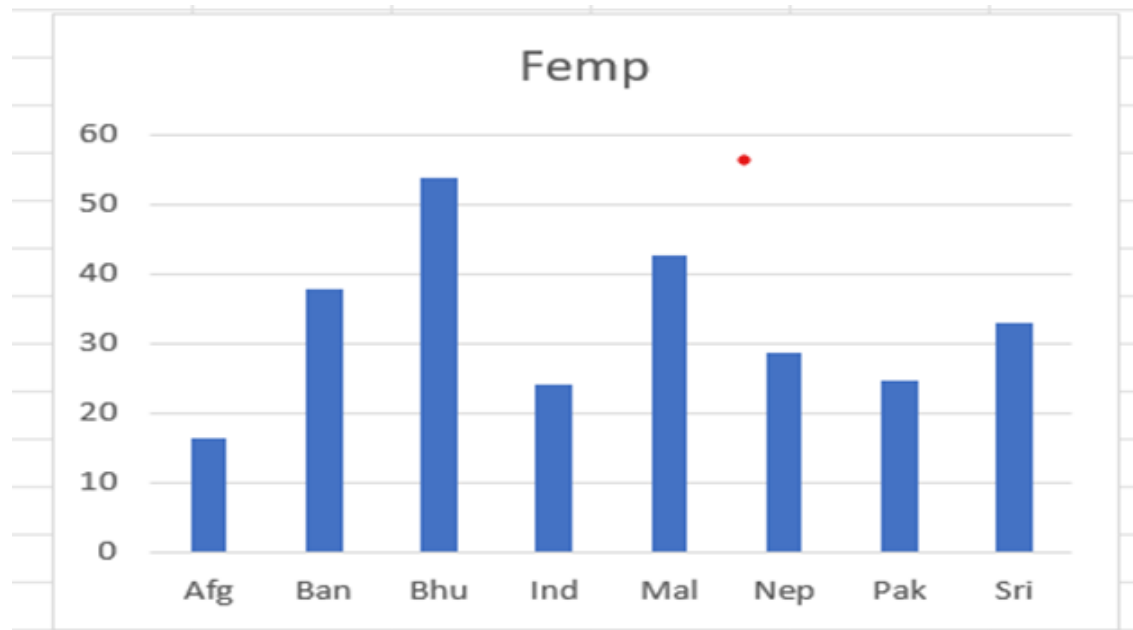
Introduction

- Climate change poses a significant obstacle to development among rural populations in low- and middle-income countries.
- Rising temperatures over the past several decades have been found to lead to a large reduction in female employment in South Asian countries.
- Additionally, extreme weather events, such as increasingly common heat waves in summer and colder winters, exacerbate the challenges faced by these communities.
- Changes in temperature and rainfall patterns are predicted to further reduce female employment, particularly in India, Pakistan, and Sri Lanka.
- The ILO (2022) report highlights a 25% gender gap in global labour force participation, with 47% for women and 72% for men.

Why South Asia Regions?

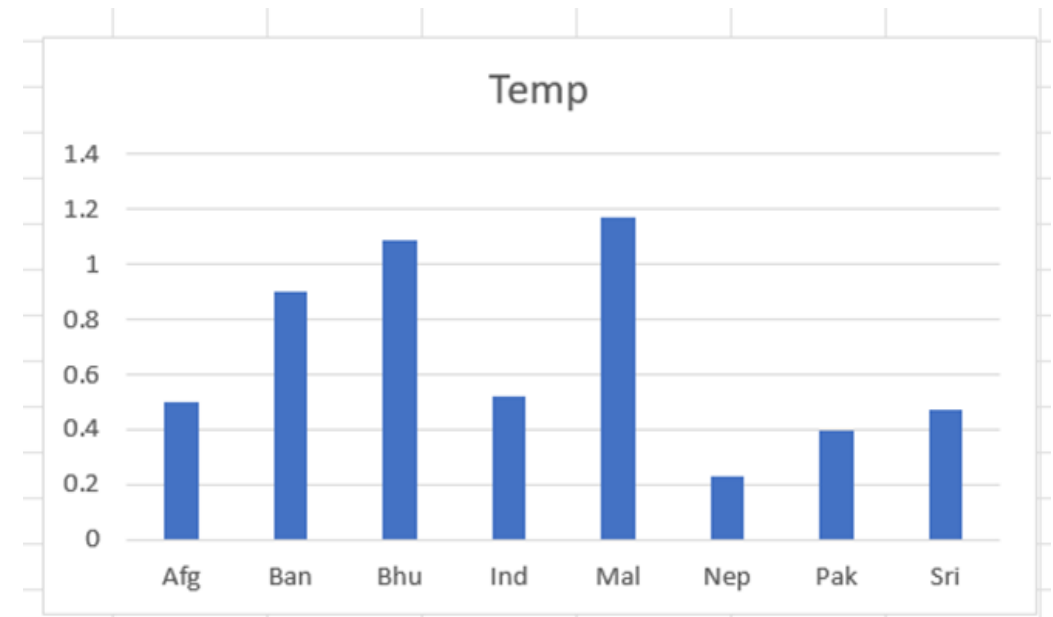
- Female are typically disadvantaged in the labour market in developing countries specifically all south Asian countries.
- In south Asia, over 80% female are involved in non-agricultural jobs in informal employment. Further, according the Global Gender Gap report (2021) shows female are the most disadvantaged in the workforce in south Asia around 33.8%.
- However, south Asia experienced the highest GDP growth rate from 4.1% in 2000 to 8.3 % in 2022 (World Bank, 2022).
- On the other hand, south Asia is the second lowest labour force participation of female i.e. 25.1% compared to Latin America Countries i.e. 58.4 in 2022 according to ILO.
- Hence, the question arises, why is female participation low in South Asia despite its fast economic growth?
- In this connection, this paper offers the new insights into the considering climatic factors, social factors and economic factors and its impact on female employment in south Asia.

Figure 1: Female Employment in South Asian Countries



Source: WDI, World Bank (2022)

Figure 2: Temperature change in South Asian Countries



Source: WDI, World Bank (2022)

Review of Literature

- *Climate Change and Female Employment Nexus:*

Authors (Year)	Countries/Region	Methodology	Findings
Mahajan (2017)	India	OLS	The female-to-male wage ratio is significantly positively associated with a rainfall shock in regions.
Zaman et al., (2018)	Pakistan	Augmented Mean Group	They found that, an inverse and significant relationship between agricultural production, female employment, consumption of renewable energy, and CO2 emissions.
Abid et al., (2018)	South Asia	Quantile-on-Quantile regression	Female generally face higher risk and greater burdens from the impact of climate change.
Ghana by Mensah et al., (2022)	Ghana	ARDL	The important difference between male and female adaptation strategies for climate change are that male prefer to migrate and seek employment and female remain at house and prefer off farm job.

Authors (Year)	Countries/Region	Methodology	Findings
Shayegh and Dasgupta (2022)	South Africa	Spatial Regression analysis	Climate change damages both on sectoral productivity and on labor availability.
Akpa et al., (2024)	Sub-Saharan Africa	Driscoll–Kraay estimator	Female labor force participation in agriculture decreases income inequality in southern and western Africa.
Iheonu et al., (2020)	South Asia	Data Envelopment Analysis (DEA)	Domestic credit, remittances and female education are positively associated with female labor force participation in the sub-region.
Muttarak & Lutz (2014)	Sweden	Wavelet Coherence (WC) approach	Education can directly influence climate risk perception, skill and knowledge and this can help indirectly reduce the poverty and improve the health and promote access of information and resources.
Randell & Gray (2016)	G7 Countries	OLS	early life climatic conditions such as mild temperatures during all seasons and high rainfall during summer are associated with increased possibility of a children having completed any education.

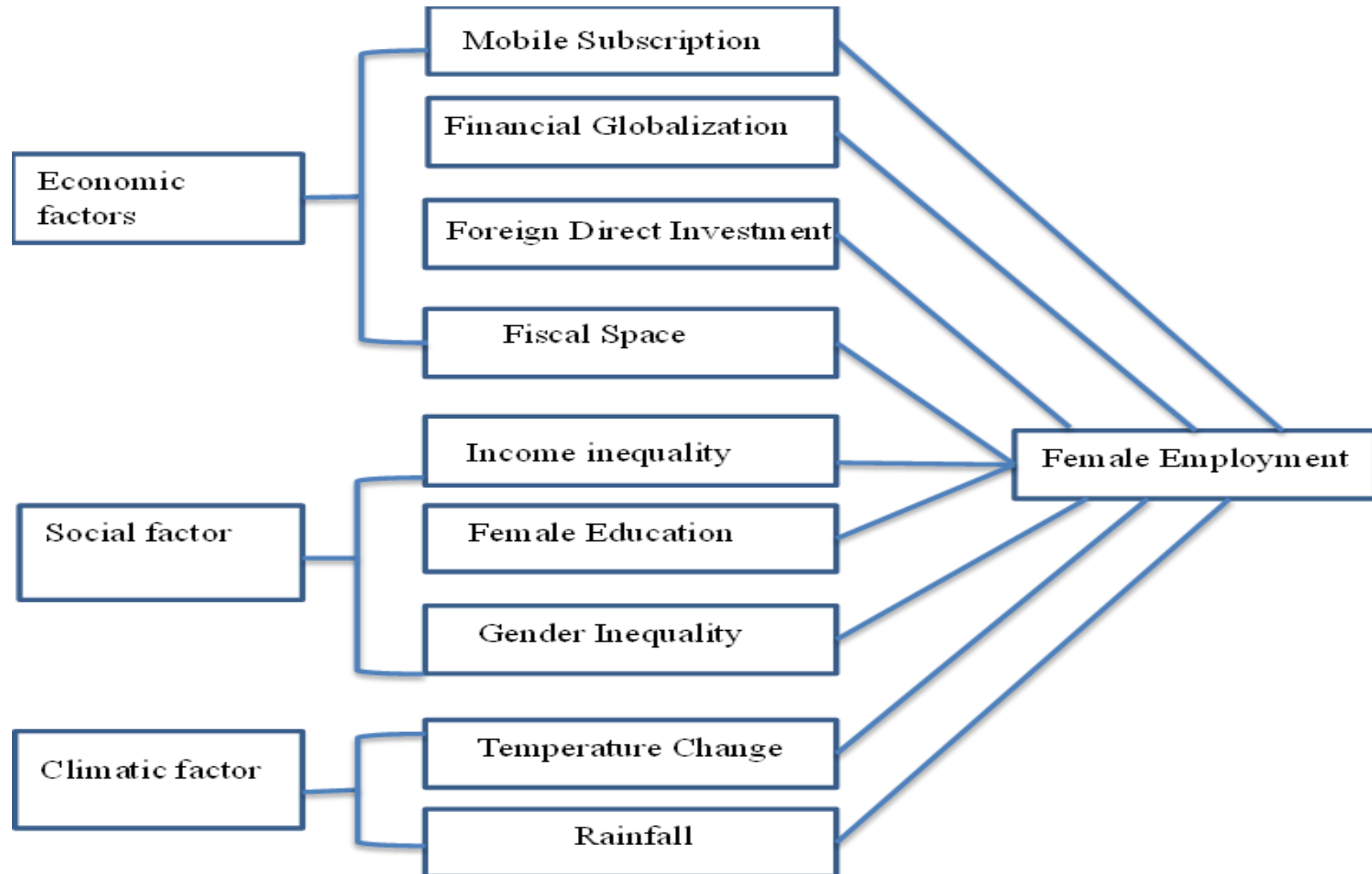
Research Gaps

- There are large number of earlier literatures only concentrate the effect of climate change on employment and other associated factors.
- However, previous studies find that climate change negatively affecting female labour force participation in various sectors.
- Gender inequality, income inequality, and female education are highly affected due to climate change.
- Most of the earlier studies are based on a single country analysis and particularly the poorest region like sub-Saharan Africa.
- Thus, this study is trying to fill the research gap by examining the effect of climate change on female labour force participation by incorporating income inequality, gender inequality, and female education.
- Further, we also examine the effects of climate change on other control variables like FDI, fiscal expenditure, mobile subscribers, and financial globalisation.
- Additionally, we encompass the interactions, we have examined the interaction effects of gender and income inequality with female labour force participation on climate change in eight south Asian countries.

Theoretical Framework

- The dimension of female labour force participation decision in economic theory has been developed with the significant contributions by Mincer (1962) and Becker (1965). (Household decision and work)
- Climate change has impacted female workforce in various ways in form of declining productivity, loss of assets, unequal income, lesser economic opportunities, and lesser economic mobility (Rosenhouse, 1989; Burke et al., 2015; Peterman, 2012).
- There is a well-documented U-shaped relationship between female labor force participation and GDP per capita (Çağatay and Özler, 1995; Goldin 1994).
- A female labour supply decision is based on the real wage she earns for the time she devoted to work relative to the value her time saving when she enjoys the leisure ([Psacharopoulos and Tzannatos, 1989](#)).

Conceptual Framework



Source: Author's Formation

Objectives of the Study:

- ❖ This study examine the impact of climate change on female employment in south Asian countries from 2000 to 2022.
- ❖ To explore the interaction effects of income inequality and gender inequality on female employment in the context of climate change.

Data and Methodology

Table 1: Variables Descriptions and Data Sources

Variables	Symbol	Measurement	Sources
Female employment	FEmp	Labor force participation rate, female (% of female population ages 15+).	World Bank
Temperature	TEMP	Temperature changes concerning a baseline climatology.	Climate Change Knowledge Portal
Annual Precipitation (Rainfall)	RAIN	Average precipitation is the long-term average in depth (over space and time) of annual precipitation in the country.	Climate Change Knowledge Portal
Income Inequality	IIneq	Gini index measures the extent to which the distribution of income (or, in some cases, consumption expenditure) among individuals or households within an economy deviates from a perfectly equal distribution.	World Bank
Gender Inequality	GI	The GII generally ranges from 0-1, with higher numbers signifying inequality	IMF
Female Education	FEdu	Educational attainment, at least completed lower secondary, population 25+, female (%) (Cumulative).	World Bank
Financial Globalisation	FG	The KOF Globalisation Index measures the economic, social and political dimensions of globalisation.	KOF Swiss Economic Institute
Foreign Direct Investment	FDI	Foreign direct investment, net inflows (% of GDP)	World Bank
Mobile Subscriptions	MS	Mobile cellular telephone subscriptions are subscriptions to a public mobile telephone service that provide access to the PSTN using cellular technology.	World Bank
Fiscal Space	FS	Gross national expenditure (% of GDP).	World Bank

Model specifications

- We frame the basic functional form for our model as follows.
- $FEmp_{it} = f(TEMP, RAIN, IIneq, GI, FEdu, FG, FDI, MS, FS)$ (1)
- Further, we examine the interaction effect of income inequality and gender inequality on female employment as follows in eqn.2.
- $FEmp_{it} = f(TEMP, RAIN, IIneq, GI, (IIneq * GI), FEdu, FG, FDI, MS, FS)$ (2)
- After transferring the dataset into natural logarithm, Eq. (3) is expressed as follow:
- $FEmp_{it} = Y_0 + Y_1 \ln TEMP_{it} + Y_2 \ln RAIN_{it} + Y_3 \ln IIneq_{it} + Y_4 \ln GI_{it} + Y_5 (\ln IIneq * \ln GI)_{it} + Y_6 \ln FEdu_{it} + Y_7 \ln FG_{it} + Y_8 \ln FDI_{it} + Y_9 \ln MS_{it} + Y_{10} \ln FS_{it} + \varepsilon_{it}$ (3)

Methodology

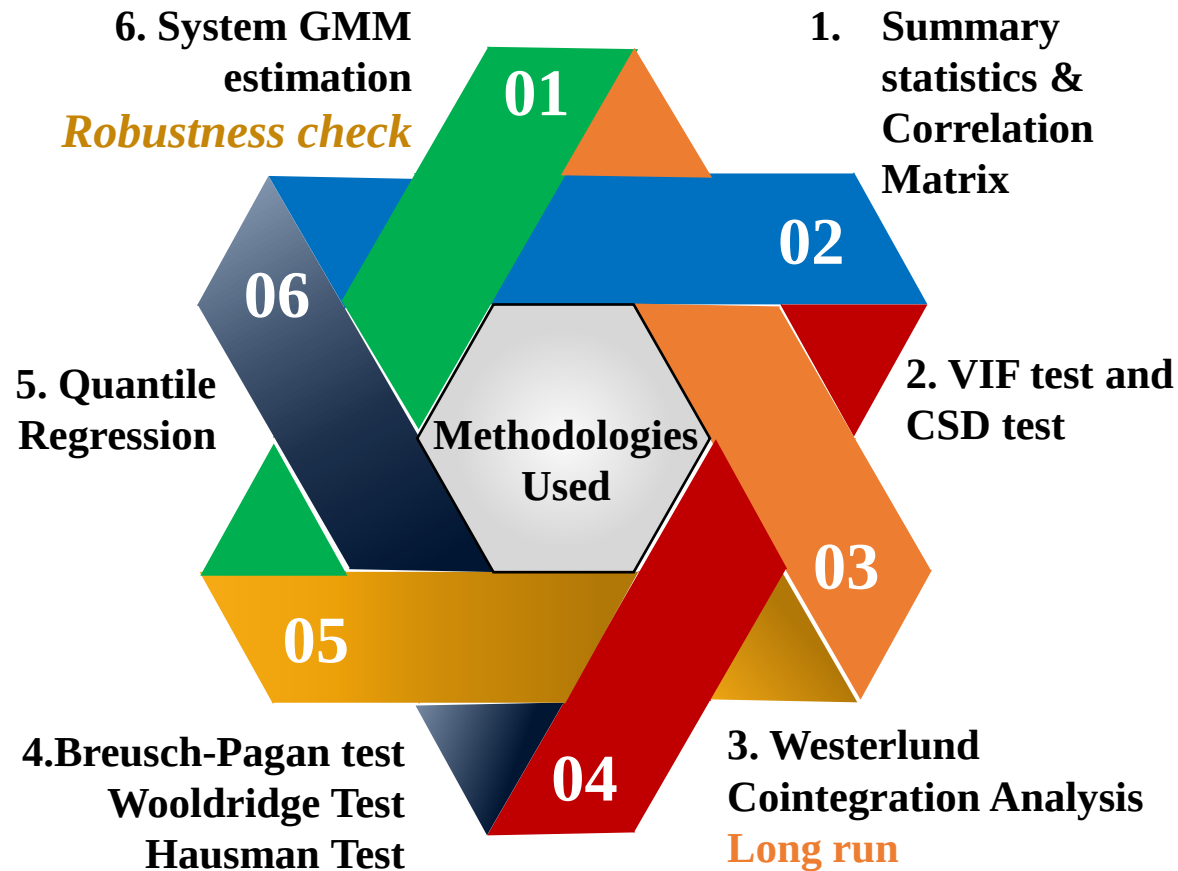


Fig 8: Methodological Framework of the study

Source: Author's compilation

- **Quantile regression** is a statistical technique used to estimate the relationship between independent variables (**predictors**) and different quantiles (percentiles) of the dependent variable (**outcome**).
- Unlike ordinary least squares (**OLS**) regression, which focuses on predicting the **mean** of the dependent variable, quantile regression provides a more **comprehensive analysis** by estimating relationships at different points of the distribution.
- **System Generalized Method of Moments (SyGMM)**:- System Generalized Method of Moments (SyGMM) is an advanced econometric technique used for estimating dynamic panel data models where there are issues like endogeneity, autocorrelation, and unobserved heterogeneity.

Empirical Results and Analysis

Table 2: Descriptive statistics and Correlation Matrix

Variable	FEmp	TEMP	RAIN	Ileq	GI	Fedu	FG	FDI	MS	FS
Mean	3.355	-0.364	6.76	1.128	-0.566	0.886	3.631	-0.008	15.214	3.428
Std. Dev	0.514	0.58	0.879	1.648	0.284	1.52	0.812	1.169	4.182	2.101
Min	0	-2.501	5.201	0	-1.075	0	0	-4.836	0	0
Max	4.184	0.542	7.891	3.779	0	4.43	4.137	2.82	20.885	4.917
S-Wilk Probability	0	0	0	0	0.024	0	0	0	0	0
S-Francia Probability	0	0	0	0	0.002	0.001	0	0	0	0
Obs	184	184	184	184	184	184	184	184	184	184
FEmp	1									
TEMP	-0.004***	1								
RAIN	0.506*	-0.305*	1							
Ileq	0.077**	-0.069**	0.201*	1						
GI	-0.227*	-0.095**	-0.058**	-0.001***	1					
FEdu	-0.084**	0.047**	-0.171*	0.249*	-0.211*	1				
FG	0.104*	-0.097**	-0.056**	0.108*	-0.564*	0.133*	1			
FDI	0.240*	0.053**	0.203*	0.032**	-0.327*	0.009**	0.062**	1		
MS	-0.087**	0.063**	-0.153*	0.260*	-0.277*	0.311*	0.320*	-0.053**	1	
FS	0.134*	-0.142*	0.060**	0.250*	0.137*	0.270*	0.128*	-0.426*	0.262*	1

Table 3: Multicollinearity test/VIF

Variable	VIF	1/VIF
Ileq	4.61	0.142
IleqGI	3.25	0.143
GI	2.17	0.460
FG	1.79	0.558
FS	1.6	0.603
FDI	1.4	0.669
RAIN	1.47	0.680
MS	1.41	0.707
FEdu	1.38	0.724
TC	1.22	0.817
Mean VIF	2.66	

Table 4: CSD Post estimation Test

Frees' test of CSD	0.885 (0.10)
Friedman's test of CSD	38.069* (0.00)
Pesaran's test of CSD	0.970 (0.33)

*Note: * is for p- values < 0.00*

- Table 3 shows that multicollinearity is not a problem for these variables because the VIF is below 5, indicating moderate collinearity among the variables.
- As a rule of thumb, we can ignore multicollinearity problem if the mean VIF does not exceed 5.
- The cross-sectional dependence (CSD) tests of Pesaran, Frees and Friedman indicate that there is exists cross-sectional dependence among the variables is presented in Table 4.

Table 5: Panel Unit root Tests

Variables	CADF		CIPS	
	I (0)	I (1)	I (0)	I (1)
FEmp	3.393**	-6.172***	-0.596	-3.877**
TC	-5.309***	-9.710*	-3.518**	-5.090*
RAIN	-4.247*	-12.102***	-3.216**	-5.910***
Ileq	-5.830***	8.790***	-3.760**	-4.775**
GI	-1.118	-3.134*	-2.143*	-2.835*
FEdu	-5.365***	-11.324***	--3.600**	-5.644***
FG	-4.886**	-8.847***	-3.436**	-4.794***
FDI	-3.315**	-8.880***	-2.897*	-4.805***
MS	-5.834**	-3.572**	-3.761**	-2.985*
FS	2.134*	-3.771**	-1.028	-3.053**

Note: ***, ** and * is for p- values < 0.10, 0.05 and 0.01 respectively.
() parentheses represent standard error.

- ❑ This study utilizes second-generation panel unit root tests suggested by Pesaran such as cross-sectionally augmented Dickey fuller (CADF) and cross-sectionally augmented Im-Pesaran, and Shin (CIPS) stationary tests with intercept and intercept with trend.
- ❑ Table 5 shows that all the variables are stationary at the first difference, *i.e.*, all the variables are autoregressive of order 1, AR (1).

Table 6: Pedroni and Westerlund Panel Cointegration Test

Modified Phillips-Perron test	4.304 (0.00)
Phillips-Perron test	4.365 (0.00)
Augmented Dickey-Fuller test	3.714 (0.00)
Westerlund test for cointegration (Variance ratio)	13.292 (0.00)

Note: () represents the P-value.

Table 7: Results of diagnostic tests

Test statistics	Value
Hausman test	94.19 (0.000)
Breusch-pagan Heteroskedasticity test	84.60 (0.000)
Wooldridge Autocorrelation test	383.21(0.000)

Note: () represents the P-value.

- Since all of them are integrated of order one $I(1)$, we perform Pedroni and Westerlund panel cointegration test to test the long-run relationship among these variables in Table 6.
- The results of Hausman test, Wooldridge autocorrelation test and Wald heteroscedasticity test are given in Table 7.
- Hausman test shows the presence of Fixed Effects, the autocorrelation and heteroscedasticity tests show the presence of both serial autocorrelation and heteroscedasticity.

Table 8: Quantile Regression Results

Quantile				
Variables	0.25	0.5	0.75	0.9
TC	0.049 [0.042]	0.116 [0.050] *	0.137 [0.041] **	0.147 [0.066] *
RAIN	0.208 [0.030] **	0.166 [0.036] **	0.156 [0.030] ***	0.148 [0.047] **
Ileq	0.074 [0.035] *	-0.025 [0.042]	0.038 [0.035]	-0.003 [0.056]
GI	-0.703 [0.116] ***	-0.533 [0.137] **	-0.449 [0.115] **	-0.164 [0.182]
FEdu	0.001 [0.017]	-0.000 [0.020]	0.007 [0.016]	0.003 [0.026]
FG	-0.080 [0.036] *	-0.073 [0.042]	-0.110 [0.035] *	-0.038 [0.056]
FDI	0.028 [0.023]	0.056 [0.027] *	0.019 [0.022]	0.050 [0.036]
MS	-0.002 [0.013]	-0.044 [0.007] ***	-0.046 [0.006] ***	-0.072 [0.009] ***
FS	0.014 [0.013]	0.090 [0.015] ***	0.072 [0.013] ***	0.019 [0.021]
Ileq*GI	0.080 [0.055]	-0.025 [0.065]	0.055 [0.055]	0.001 [0.087]

Note: [] values show the S.E *, **, & *** denotes 0.01, 0.05, & 0.10 significance level, respectively

Table 8 presents female employment as a function of temperature and rain as both are representing climate change with some other control variables for fuller panel at different quantiles.

Control variables included in the analysis are gender inequality, income inequality, female education, FDI, Financial globalisation, fiscal expenditure and mobile subscribers’.

The empirical results in Table 5 indicate that coefficients of Female Employment (FEmp) exhibit mixed response to climate change (i.e. temperature change and Rainfall).

We find that, change of temperature (TEMP) affects the female employment positively in different quantile like 50th, 75th and 90th.

That shows female is positively affected due to temperature change in south Asian countries during our study period.

However, the rainfall affected also the female employment positively but in all quantiles. The other control variables like income inequality and gender inequality also affects the female employment in different quantile. But gender inequality affects the female employment negatively.

Robustness check

Table 9: System GMM estimation Results

Female employment (FE)	I	II
FE (-1)	0.206 (0.216)	0.936* (0.071)
Temp	0.001 (0.030)	-0.036 (0.032)
Rainfall	0.260* (0.094)	0.298* (0.064)
Income Inequality	0.003 (0.010)	0.024* (0.011)
Gender Inequality	-0.020 (0.184)	-0.249** (0.132)
Female education	0.004 (0.012)	0.010 (0.013)
Financial Globalization	0.061*** (0.038)	-0.011 (0.029)
FDI	-0.006 (0.024)	0.079* (0.024)
Mobile Subscription	-0.006 (0.010)	-0.023* (0.007)
Fiscal Space	-0.048** (0.025)	-0.053* (0.017)
Constant	0.917 (0.834)	-1.421* (0.383)
Methods	Dynamic GMM	System GMM
No of instruments	31	52
SARGAN Test P Value	0.213	0.000

Notes: Standard errors are reported in parentheses under the values of coefficients.

- ❑ The GMM estimation is used for models with endogenous variables, in particular lagged dependent variables, when the time horizon is short.
- ❑ we notice that lagged values of female employment positively influence female employment of present year.
- ❑ Temperature change impacts differently the female employment, although in later estimation, we find the inverse relation between temperature change and female employment. Improvement in rainfall trend impacts female employment positively.
- ❑ From the inequality perspective, both income and gender inequalities impact female employment differently.
- ❑ Moreover, we notice that gender inequality influences female employment inversely. Our estimation reveals that every 1% change in gender inequality impacts female employment 0.20% to 0.249% over the year and results come out significantly for the region.
- ❑ Female education needs to be improved and the governments in the region need to invest heavily towards the gender specific education with a greater rigor to the primary and secondary education levels. Other control variables like FDI and mobile subscription has imbibed negative impacts on the female employment levels, although reasons remain unclear.

Conclusion and Policy Implications

- From our empirical strategies, we find that temperature change impacts female employment negatively in the region, whereas rainfall exerts positive impacts upon the female employment.
- Inequality remains the headache and stumbling block for the region. Increase in income inequality leads to a greater decline in female employment across sectors, where they are hard hit by the crisis.
- Gender inequality further widens the gap in terms of lack of opportunities and wage discrimination in the regions.
- Economies like India, Sri Lanka and Bangladesh have been hard hit by this post-pandemic gender discrimination scenario significantly across sectors.
- From other variables' perspectives, we notice that improvement in FDI and financial globalization enhance the probability of female employment scenarios.
- It further states that the development needs to be gender sensitive over the years.
- Further, we find that improvements in female education have also improved the perspectives of female employment to a significant extent.

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Thank You