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GEARING UP FOR SUSTAINABILITY: ECONOMIC DRIVERS AND EMISSION TRENDS OF ICE VEHICLES IN INDIA

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Abstract

This study investigates the macroeconomic determinants and environmental implications of private internal combustion engine (ICE) car sales across developed and developing countries, with a specific focus on India. Using panel regression techniques, the research examines the roles of income (GDP per capita), labor force size, fuel prices, and vehicle production in shaping car demand in both economic contexts. A time series analysis is conducted for India to evaluate the country-specific effects of these variables on private car sales. Furthermore, an emission index has been constructed to quantify the environmental impact of ICE car growth by calculating pollutant emissions (CO, NO_x, SO_2, and PM) over a 32-year period. The findings reveal that while income and labor force expansion significantly influence car sales globally, gasoline prices have varying impacts across regions. In India, vehicle production is the primary driver of car sales, with fuel costs also exerting a notable effect. The emission index highlights a concerning rise in vehicular pollution, underscoring the urgent need for sustainable transport interventions. This study advocates for a comprehensive policy framework promoting clean mobility, stricter emission norms, and investment in public and non-motorized transport to align with global sustainability goals.

Keywords: Car Sales, GDP per capita, Gasoline Prices, Sustainable Transport, Air Pollution

JEL Classification: L62, O11, Q41, R4, Q53

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Introduction

The automobile industry is a cornerstone of economic development in both advanced and emerging economies. It stimulates industrial output, generates employment, and contributes significantly to gross domestic product (GDP). As nations progress economically and demographically, the demand for private vehicles tends to increase, particularly in urban areas where the aspirations for mobility and lifestyle improvements are prominent (Dargay & Gately, 1999; Dargay, Gately & Sommer, 2007). However, this growing demand raises pressing concerns about energy consumption, environmental degradation, and long-term sustainability—especially in the context of climate change and global commitments to decarbonization.

Private car ownership has risen steadily in many countries, acting as a barometer of economic prosperity and urban growth. This trend is especially pronounced in developing nations, where rising income levels, increased industrialization, and expanding labor markets have driven higher vehicle demand (Javid & Sadeghian, 2019). Among the key macroeconomic factors influencing automobile sales are GDP per capita, fuel prices, labor force participation, and the scale of internal combustion engine (ICE) vehicle production. Studies indicate that vehicle demand grows rapidly with income in lower-income countries but begins to saturate in high-income countries, highlighting the importance of differentiating demand patterns by economic context (Dargay & Gately, 1999; Dargay, Gately & Sommer, 2007). Additionally, higher fuel prices often deter car ownership, particularly in regions where household expenditure is sensitive to fluctuations in energy costs.

However, the continued reliance on ICE vehicles is increasingly being scrutinized due to their adverse environmental impacts. The transportation sector is responsible for about 23% of global energy-related carbon dioxide emissions, with road transport contributing nearly three-quarters of this share (IEA, 2021). ICE vehicles are significant emitters of pollutants such as nitrogen oxides (NO_x), carbon monoxide (CO), hydrocarbons (HC), and particulate matter (PM), especially in countries where vehicle regulations and emissions controls are evolving (Javid & Sadeghian, 2019). In India, for instance, the rapid growth of private vehicle ownership has coincided with worsening air quality. According to the World Health Organization (2018), several Indian cities are among the world's most polluted, with vehicular emissions being a major contributor to PM2.5 and NO_x concentrations (MoEFCC, 2018).

The environmental urgency has prompted a global rethink of mobility paradigms. International frameworks such as the United Nations Sustainable Development Goals (SDGs) advocate for inclusive, safe, resilient, and sustainable urban transport systems. Notably, Goal 11 (Sustainable Cities and Communities), Goal 12 (Responsible Consump-

tion and Production), and Goal 13 (Climate Action) stress the need for low-carbon mobility solutions and the reduction of environmental footprints associated with urbanization (United Nations, 2015). Against this backdrop, many countries are formulating policies to curb ICE vehicle dependence and accelerate the transition to electric vehicles, improve fuel efficiency, and strengthen public transportation networks (Dhar & Shukla, 2015).

In this context, a nuanced understanding of the economic and industrial drivers of car sales is essential for informing transition strategies. It is also critical to evaluate the environmental consequences of the prevailing automobile usage patterns. The present study aims to explore both dimensions.

Literature Review

This study explores the macroeconomic factors influencing the sales of private four-wheelers, with a focus on both global and Indian contexts. In India and abroad, the rapid rise in private vehicle ownership has brought significant environmental challenges, including air pollution, traffic congestion, and emissions from internal combustion engine vehicles. To understand these factors, an extensive literature review has been conducted, some of which is mentioned below, highlighting the economic drivers of automobile sales and the urgent need for sustainable transport policies.

Rising Road Transport and Macroeconomic Determinant

1. Caid (2004) provides a comprehensive analysis of the relationship between transport infrastructure and economic growth. The paper highlights how transport systems facilitate the mobility of people and goods, which is essential for productivity, GDP growth, and employment. As economies grow, the demand for transportation increases, driving the need for investments in transport infrastructure. Caid examines the dual role of transport in stimulating economic growth and the challenges posed by environmental pressures such as congestion and pollution. The study underscores the importance of improving transport networks while also addressing external costs, like emissions, to ensure sustainable development. The paper calls for a balanced approach that considers both economic and environmental factors in transport policy.
2. Bharadwaj (2015) discusses the rapid transformation of the global automobile industry, which has long been a major driver of economic growth in developed economies. The paper emphasizes how the shift in production and demand has moved toward emerging economies like China, India, and Brazil due to their expanding middle classes. Despite challenges such as pollution, congestion, and energy insecurity, these countries have become central to the industry. The author notes how

governments have implemented regulations and provided incentives to promote cleaner technologies. Technological innovations, including internal combustion engine improvements, electric and hybrid vehicles, and alternative fuels like LNG and ethanol, are discussed as key trends in the industry. The paper also highlights that while internal combustion engine vehicles dominate due to cost and infrastructure constraints, increasing environmental consciousness and stricter emission norms are gradually driving the industry toward a more sustainable future.

3. Vlahinić Lenz et al. (2018) analyze the macroeconomic effects of transport infrastructure on economic growth in Central and Eastern European Member States (C.E.M.S.) over a period of two decades (1995-2016). They highlight the critical role of transport infrastructure, especially road networks, in facilitating trade and stimulating economic growth. However, the study emphasizes that rail infrastructure in C.E.M.S. countries has been underdeveloped, limiting potential economic growth. Using panel data analysis, the study finds that road infrastructure and trade openness have a positive effect on GDP growth, whereas rail infrastructure shows a negative impact, possibly due to underinvestment. The authors argue that increased investment in rail infrastructure is essential for sustainable economic growth and aligning with the European Union's environmental objectives.

4. The role of transportation infrastructure in regional economic development is examined by Li et al. (2020), who demonstrate the significant link between transportation activity and GDP in China. By analyzing highway toll data, the study reveals that transportation flows, particularly in freight and private services, are strongly correlated with economic growth. This research underscores the role of advanced transportation networks, such as highways and high-speed rails, in fostering regional development. However, it also notes the risks of uneven benefits and negative impacts on bypassed regions, highlighting the complexities of transportation's role in economic integration and development (Li et al., 2020).

Urbanization and its Associated Challenges

5. Singh (2012) emphasizes India's rapid urbanization, predicting that by 2021, urban populations will reach 500 million, contributing over 60% to national income. Despite this economic growth, urban transportation systems are overwhelmed, leading to severe congestion, pollution, and high accident rates. Indian cities, despite lower vehicle ownership compared to developed nations, experience frequent traffic jams, with peak-hour speeds often dipping below 10 km/h in cities like Kolkata. Singh argues that the concentration of vehicles in metros (35% of vehicles serving only 11% of the population) exacerbates congestion, with buses representing a negligible portion of urban transport (e.g., 0.7% in Delhi). The study

highlights how this inefficiency, combined with inadequate public transport infrastructure, worsens urban air quality and road safety (Singh, 2012).

6. Chakrabartty and Gupta (2014) address the issue of traffic congestion in Kolkata, one of India's largest metropolitan cities. They discuss the broader trend of urbanization, with increasing urban populations driving demand for efficient transportation systems. The paper outlines the factors contributing to congestion in Kolkata, including inadequate public transport, inefficient traffic management, and a growing number of private vehicles. The authors emphasize the negative impacts of congestion, including increased pollution and social inefficiency. The study suggests that improving public transport, investing in road infrastructure, and enforcing traffic laws could mitigate congestion and improve the urban transport system. They argue that addressing these issues is critical for the economic and environmental sustainability of growing cities like Kolkata.

7. The issue of traffic congestion is a global concern, as evidenced by Koźlak and Wach (2018), who discuss the causes of congestion in Polish cities. The study notes that high motorization rates and urban sprawl contribute significantly to traffic problems. Despite efforts to expand infrastructure and promote alternatives like public transport and cycling, congestion remains persistent. The authors argue that demand-side factors, such as car ownership and suburbanization, have a more profound effect on congestion than supply-side measures. Integrated approaches, combining infrastructure improvements with spatial planning and behavioral change, are necessary for effective traffic management (Koźlak & Wach, 2018).

8. The issue of urban sprawl and its connection to increased car ownership is further explored by Kołsut and Kudłak (2024), who investigate Poland's transition from systemic to sustainable development. The study examines how urban sprawl and the automobile revolution have contributed to environmental degradation, particularly in emerging economies like Poland. The findings suggest that regions in transition economies face unique challenges in balancing economic growth with environmental sustainability, requiring tailored, context-specific policies. The authors stress the need for a geographically sensitive approach to addressing urban sprawl, car ownership, and their environmental impacts (Kołsut & Kudłak, 2024).

Environmental Concerns and SDG Goals associated with Transport

9. Zhao (2010) explores the environmental challenges posed by rapid urban expansion,particularly focusing on megacities in developing countries. With the expectation that 70% of the world's population will live in cities by 2050, the study discusses the significant pressures that urban sprawl, particularly in cities like Beijing, places on transportation systems. The paper argues that the increasing

reliance on private vehicles due to suburban expansion is undermining the gains made from technological improvements in transportation. Zhao stresses the need for urban growth management strategies, which have been effective in Western countries, to curb sprawl, reduce long-distance travel, and encourage the use of public transport. Through the case study of Beijing, the paper highlights the negative environmental impacts of decentralized urban growth and the importance of managing land development to foster more sustainable mobility solutions.

10. Liddle (2015) revisits the Environmental Kuznets Curve (EKC) theory in the context of urban transport pollution. The paper examines how economic development leads to increased pollution, but at a certain level of income, pollution is expected to decline due to technological advancements and environmental policies. Focusing on urban transport, Liddle discusses how rising income and motorization contribute to air pollution and greenhouse gas emissions, which is particularly evident in rapidly developing cities. The paper critiques the EKC model in the context of transport pollution, arguing that while economic growth can lead to environmental improvements, this relationship is not automatic. The author stresses the importance of proactive policies and investments in clean technologies to ensure that urban transport systems do not exacerbate environmental degradation.

11. The relationship between transportation infrastructure and sustainable development is explored in Wang et al. (2018), which highlights the dual role of transport infrastructure in promoting economic growth while simultaneously posing risks such as environmental degradation and inefficiencies. The study underscores the importance of aligning transportation development with low-carbon, resilient goals to minimize ecological damage. As cities expand, the environmental impacts of poorly planned infrastructure become more evident, particularly in terms of emissions and habitat loss. The authors argue for the need for comprehensive environmental assessments to guide future infrastructure projects that balance growth with sustainability (Wang et al., 2018).

12. Similarly, Borck (2019) addresses the role of public transport in reducing air pollution and greenhouse gas emissions. Public transport, when properly subsidized, can serve as a key tool for shifting commuters from private cars, thereby reducing per capita emissions. However, Borck notes that evidence regarding the effectiveness of various public transport systems in reducing pollution remains mixed, with substantial challenges in capturing the full impact of structural factors like urban design and transport costs (Borck, 2019).

13. At a broader global level, the Sustainable Development Goals (SDGs) articulated by the United Nations (CEPAL, 2019) provide a framework for integrating sustain-

ability into urban transportation systems. Specifically, SDG 11 emphasizes making cities more sustainable by ensuring access to affordable public transport and reducing air pollution, both of which are directly influenced by transportation systems. SDG 7 focuses on promoting clean energy, which is integral to reducing emissions from conventional internal combustion engine vehicles. The SDGs emphasize the urgent need to transition to sustainable transportation systems, including electric vehicles (EVs), to mitigate environmental impacts and foster resilient cities (CEPAL, 2019).

14. In Ho Chi Minh City, Vietnam, the challenge of rapid motorization and its environmental impact is explored in a case study. The research finds that motorcycles dominate urban transport, despite improvements in bus services, contributing to severe traffic congestion and air pollution. Using a binary logit model, the study identifies factors influencing commuting choices, such as convenience, safety, and socioeconomic factors, and suggests that better bus services could lead to a substantial reduction in carbon emissions. This aligns with global findings showing the positive impact of improved public transport in reducing environmental harm, particularly in rapidly urbanizing areas (Ho Chi Minh City Case Study, 2020).

15. (UNEP, 2021) in this background paper no. 15 named "THE ROLE OF THE TRANSPORT SECTORIN ENVIRONMENTAL PROTECTION" discusses the transport sector's crucial role in socio-economic development and its significant environmental impacts. While transport is a key contributor to global GDP and employment, it also presents substantial environmental challenges, including air pollution, greenhouse gas emissions, and climate change. The sector is one of the largest consumers of energy, and its reliance on fossil fuels exacerbates global warming. As urbanization and population growth continue, the demand for transportation will rise, further increasing environmental pressures. The article emphasizes the need for sustainable mobility solutions that reduce the environmental footprint of transport systems while meeting the growing demand for mobility. It calls for collaboration among multinational corporations, governments, and other stakeholders to balance the economic benefits of the transport sector with environmental protection goals.

Research Gap

1. While numerous studies have analysed demand patterns or environmental impacts of private vehicles in general, few have explicitly compared macroeconomic drivers of private car sales across developed and developing countries using a unified framework (like panel regressions across consistent timeframes).

2. The role of labor force size and participation rates in influencing car demand—

especially as a proxy for mobility demand is rarely included in Indian demand studies.

3. Despite widespread recognition of air quality issues, few studies include an explicit emission index in econometric modelling of private car demand in India.
4. Prior work often uses different econometric techniques across countries, making cross-regional comparison difficult. This study proposes a unified panel regression across developed and developing economies, addressing this.

Objectives

1. To analyze and compare the macroeconomic determinants of private car sales across developed and developing countries using panel regression techniques.
2. To examine the influence of income, fuel prices, labor force, and ICE private cars production on private car demand (sales of ICE private cars has been taken as a proxy for demand) in India through time series analysis.
3. To assess the emissions from ICE private cars in India by formulated an Emission Index, incorporating calculated emissions of four key pollutants from vehicles.

Data & Methodology

For the first and the second objective the data have been collected from World Bank website, International Organization for Motor Vehicle Manufacturers, World Economic Forum websites, Statista, Indiastat and from various literatures. Later these data have been merged by the researcher for running the empirical models.

The methodologies that have been used in this paper for the first two objectives are panel regression and time series regression among the others.

A panel data regression analysis was performed to explore the factors influencing the sales of private internal combustion engine (ICE) cars, examining both developed and developing countries separately. For developed countries, two regression models were utilized: one incorporating the private ICE car production, GDP per capita, and gasoline prices, and another including the private ICE car production, the total labor force, and gasoline prices. Similarly, two separate regressions were conducted for developing countries to assess the significance of these variables. The dependent variable for each case is private ICE car sales, and the independent variables include the private ICE car production, GDP per capita, gasoline prices, the total labor force. This approach allows for the examination of how different socioeconomic indicators affect private car sales across different economic contexts.

The models for the panel regression are:

- The model for the developed countries is given as below:

  Total observation (N) = 316 (Country wise 17 year's panel data)

  No. of explanatory variables (k) in the equation is 3

Equation 1: $Y_{it}=\alpha+\beta_0 X_{0it}+\beta_1 X_{1it}+\beta_2 X_{2it}+\epsilon_{it}$

i= 1, 2, 3,…., 19

t = 1, 2,…, 17

Y_{it} = Log of Sales of private ICE cars

α =Intercept

β_0= Coefficient of variable Log of Production of ICE private cars

X_{0it}= Log of Production of ICE private cars

B_1= Coefficient of variable Log of GDP per capita (constant)

X_{1it}= Log of GDP per capita (constant)

β_2= Coefficient of gasoline prices (in $)

X_{2it}=Gasoline prices (in $)

ϵ_{it}=Residual

Equation 2: $Y_{it}=\alpha+\beta_0 X_{0it}+\beta_1 X_{1it}+\beta_2 X_{2it}+\epsilon_{it}$

In Equation 2 only the Log of GDP per capita has been replaced by Log of Total Labor Force.

- The model for the developing countries is given as below:

  Total observation (N) = 153 (Country wise 17 years' panel data)

  No. of explanatory variables (k) in the equation is 3

  Equation 3: $Y_{it}=\alpha+\beta_0 X_{0it}+\beta_1 X_{1it}+\beta_2 X_{2it}+\epsilon_{it}$

  i= 1, 2, 3,…., 9

  t = 1, 2,…, 17

Y_{it} = Log of Sales of private ICE cars

α =Intercept

β_0= Coefficient of variable Log of Production of ICE private cars

X_{0it}= Log of Production of ICE private cars

B_1= Coefficient of variable Log of GDP per capita (constant)

X_{1it}= Log of GDP per capita (constant)

β_2= Coefficient of gasoline prices (in $)

X_{2it}=Gasoline prices (in $)

ϵ_{it}=Residual

Equation 4: $Y_{it}=\alpha+\beta_0 X_{0it}+\beta_1 X_{1it}+\beta_2 X_{2it}+\epsilon_{it}$

In Equation 4 only the Log of GDP per capita has been replaced by the Log of Total Labor Force.

The separate regressions for developed and developing countries to understand how the factors affect car sales in each group have been performed. The choice between fixed effects (FE) and random effects (RE) models depends on the assumptions about the relationship between unobserved factors and the independent variables. The choice between fixed effects and random effects models depends on the underlying assumptions about the relationship between unobserved heterogeneity and the independent variables. If there is reason to believe that the individual-specific effects are correlated with the explanatory variables, fixed effects models may be preferred. If the assumption of uncorrelated individual effects is reasonable, random effects models can be more efficient.

Fixed Effects (FE): In panel regression, fixed effects refer to individual-specific or time-invariant effects that are included in the model to account for unobserved heterogeneity or variation that is specific to each individual or entity in the panel data. Fixed effects capture constant differences across entities or individuals that do not change over time.

Random Effects (RE): In panel regression, random effects refer to individual-specific effects that are assumed to be uncorrelated with the independent variables. Random effects models are used to account for unobserved heterogeneity or variation that is specific to each individual or entity in the panel data.

For the second objective a time series regression has been done. To determine whether the sales of private cars of India is being affected by the production of private cars in India, GDP per capita of India, total labor force and the gasoline price of India, two time

series regressions has been done. The data has been retrieved from Indiastat.com, SIAM reports and World Bank website. The data has been collected for the year 1994-2022.

Equation 5: $Y_t = \alpha + \beta_1 X_{1t} + \beta_2 X_{2t} + \beta_3 X_{3t} + \varepsilon_t$

t = 1, 2, 3, ……, 28

Y_t= Log of Sales of private ICE cars of India

α = Intercept

β_1 = Coefficient of variable Log of Production of private ICE cars in India

X_{1t} = Log of Production of private ICE cars in India

β_2 = Coefficient of variable Log of GDP per capita of India

X_{2t} = Log of GDP per capita of India

β_3 = Coefficient of gasoline prices of India

X_{3t} = Gasoline prices of India

ε_t = Residual

Equation 6: $Y_t = \alpha + \beta_1 X_{1t} + \beta_2 X_{2t} + \beta_3 X_{3t} + \varepsilon_t$

The Log of GDP per capita has been replaced by Log of Total labor force in Equation 6.

Initially to test the stationarity of the variables, unit root test has been conducted. The result of the Augmented Dickey Fuller test shows that all the variables are not stationary and has a unit root. Hence, the first difference of the variables has been created. After that again, the Augmented Dickey Fuller test has been run and the result showed that all the variables with first difference are stationary.

The Johansen Cointegration test has been conducted to see whether there exists any long run relationship among these variables. The result showed that the lag length is 0 for equation 5 and lag length is 1 for equation 6 and there exists a long run relationship among the variables. The lag length 0 and 1 has been selected because till that the value of trace statistics is greater than the value of the 5% critical value respectively.

In all of the above regression analysis, the logarithm value of the variables has been taken to mitigate the influence of outliers in the data used for regression analysis. Log transformation significantly reduces the scale of data. Values that are very large are scaled down more dramatically than smaller values, compressing the range of the data.

In the third objective, an effort is made to quantify the emissions of four pollutants: carbon monoxide (CO), particulate matter (PM), nitrogen oxides (NOx), and sulphur dioxide (SO2) for India. In alignment with the objective, the estimation of pollutant emissions was conducted utilizing an emission index. The emissions were calculated by employing data on the quantity of private cars, the distance they travelled, and the emission factors for these vehicles, as adopted from Gurjar et al. (2010). The computation was carried out using the following formula:

$E = \sum (V_i \times D) \times e_i$

Here:

- E represents the emissions of pollutants.

- V_i signifies the count of vehicles (private cars).

- D denotes the distance covered in kilometres.

- e_i stands for the emission factor corresponding to the pollutant emitted by vehicles in private car category

'D' was determined based on the utilization factor of vehicles. According to Gurjar, et.al. 2010 'D' was considered as 19199 km per year. Emission factors 'e_i' are typically calculated and made available by various governmental and automobile institutions. For this study, the emission factors data sourced from the Automotive Research Association of India (ARAI, 2008), www.transportpolicy.net/standard-emissions and Gurjar, et.al. (2010). Notably, this study concentrated on private cars.

Emission factors are given in Table 1:

Table 1

Years	Emission Factors			
	CO	**PM**	**NO_x**	**SO_2**
Pre 1995	17.3	0.25	3.2	0.25
1996-2000	5	0.25	1.9	0.25
Post 2000	2.72	0.14	0.6	0.08
Post 2005	1	0.08	0.12	0.053
Post 2010	0.64	0.05	0.5	0.053
Post 2015	0.5	0.025	0.25	0.02
Post 2020	0.5	0.0045	0.08	0.02

Key Findings

Objective 1: To analyze and compare the macroeconomic determinants of private car sales across developed and developing countries using panel regression techniques.

Developed Countries

United Nations have divided countries into two major categories- developed countries and developing countries. This classification of countries is based on their economic status like GDP per capita, GNP, industrialization, per capita income, etc. (Retrieved from, https://keydifferences.com/difference-between-developed-countries-and-developing-countries.html, retrieved on December 7, 2022). The countries that have been taken here into consideration for the study are Australia, Austria, Germany, United States of America, Japan, United Kingdom, Canada, Italy, France, Spain, Russia, Belgium, Turkey, Romania, Poland, Portugal, Finland, Slovenia and South Korea.

Results of Equation 1

Table 2

Variables	Coeff.	P-value
Log of Production of Private ICE Cars	.0459431	0.148
Log of GDP per capita (Constant)	.5833749	0.000*
Gasoline Prices	-.0956945	0.000*
R-sq: within = 0.1273 between = 0.2690 overall = 0.2677		

The results are derived from a fixed-effects (within) regression analysis that examines the influence of private ICE (internal combustion engine) car production, GDP per capita, and gasoline prices on the sales of private ICE cars across 19 countries, based on 316 observations (see Table- 2). By accounting for time-invariant country-specific characteristics, the fixed-effects model provides a more accurate assessment of how these variables impact car sales over time within each country. This approach was chosen for its ability to better capture cross-country differences across years.

The analysis indicates that increased production of ICE private cars does not significantly affect their sales. However, economic conditions and fuel prices are influential

factors. Higher GDP per capita is associated with increased ICE car sales, suggesting that rising income levels encourage car ownership. On the other hand, higher gasoline prices are linked to a decline in ICE car sales, likely due to consumers seeking more fuel-efficient or alternative vehicle options. The model's R-squared value of 12.73% implies that other date unaccounted-for factors also play a role in determining car sales.

Results of Equation 2

Table 3

Variables	Coeff.	P-value
Log of Production of Private ICE Cars	.0789418	0.011*
Log of Total Labor Force	.8264136	0.000*
Gasoline Prices	-.0938847	0.000*
R-sq: within = 0.0944 between = 0.8237 overall = 0.7944		

The analysis began by applying both fixed-effects and random-effects panel regression models to examine the determinants of private internal combustion engine (ICE) car sales across 19 countries. Based on the results of the Hausman test, the random-effects model was selected as the more appropriate approach, indicating that the unobserved country-specific factors—such as technology, infrastructure, and demographic trends—are likely uncorrelated with the explanatory variables included in the model. The random-effects GLS regression assessed the impact of the logarithm of private ICE cars production levels, total labor force, and gasoline prices on the logarithm of private ICE car sales. The findings (in Table 3) revealed that all three factors significantly influence sales: higher production levels and a larger labor force are associated with increased car sales, suggesting that supply capacity and economic activity drive demand. Conversely, rising gasoline prices negatively affect ICE car sales, highlighting consumer sensitivity to fuel costs and a potential shift towards more efficient or alternative vehicles. These insights are valuable for policymakers designing economic, labor, and energy policies that influence vehicle markets, as well as for automakers seeking to align their production and marketing strategies with labor trends and fuel price fluctuations. The difference in variable significance across models may depend on the set of explanatory variables used; for

example, car production may appear insignificant when GDP per capita or fuel prices are present due to overlapping influence but becomes significant when paired with variables like the labor force, which may capture different dimensions of demand. Additionally, variations in market responses across countries suggest that increased production boosts sales in some regions, while in others, factors like market saturation or high fuel costs may suppress demand despite increased supply. Ultimately, the decision between fixed and random effects models hinges on whether unobserved factors are correlated with the explanatory variables. Fixed-effects models are preferred when such correlations exist to avoid bias, while random-effects models are more suitable when these factors are assumed to be random and uncorrelated. The Hausman test provides statistical validation for selecting the appropriate model in such cases.

Developing Countries

Developing countries refer to countries or economies with a per capita income that is lower than that of the developed world. (https://www.studysmarter.co.uk/explanations/macroeconomics/international-economics/developed-countries/) Certainly, these countries are identified by their low Human Development Indices like low GDP, high illiteracy rates, poor infrastructure, communication, transportation and medical facilities, unequal distribution of income, poverty, high level of unemployment, high death rate and birth rate, etc. The countries that have been taken into consideration are Argentina, Brazil, China, India, Indonesia, Mexico, Thailand, Egypt and South Africa.

Results of Equation 3

Table 4

Variables	Coeff.	P-value
Log of Production of Private ICE Cars	.237405	0.000*
Gasoline Prices	.22954	0.000*
Log of GDP per capita (Constant)	1.084737	0.000*
R-sq: within = 0.5401621 between = 0.08682917 overall = 0.97481142		

A fixed-effects regression analysis was conducted to explore the impact of the logarithm of production, gasoline prices, and the logarithm of GDP per capita on private ICE car sales across nine countries, using a dataset comprising 153 observations. By accounting for time-invariant country-specific factors, the analysis focused on how these relationships evolve over time within each country. The results revealed a significant positive association between car production and sales, suggesting that higher production levels are likely to lead to increased sales. Interestingly, gasoline prices also showed a significant positive correlation with car sales, which may point to underlying influences not captured in the model—such as advancements in fuel efficiency or shifts in consumer preferences. Additionally, GDP per capita was found to be positively and significantly related to car sales, indicating that higher income levels encourage greater vehicle ownership. The unexpected finding that rising gasoline prices coincide with increased car sales suggests the need for further research into changing consumer behaviour, potentially highlighting a move toward more fuel-efficient or premium vehicle segments.

Results of Equation 4

Table 5

Variables	Coeff.	P-value
Log of Production of Private ICE Cars	.4336009	0.000*
Gasoline Prices	.2269078	0.000*
Log of Total Labor Force	.5572678	0.000*
R-sq: within = 0.2229266 between = 0.1040955 overall = 0.82098977		

A random effect generalized least squares (GLS) regression model (in Table 5) for panel data was employed to examine the impact of production levels, gasoline prices, and the total labor force on private ICE car sales across nine countries, with each country contributing 17 observations, resulting in a total of 153 observations. This model captures both intra-country and inter-country variation, operating under the assumption that individual country-specific effects are not correlated with the independent variables. The analysis revealed a statistically significant positive relationship between car production and sales, suggesting that higher production volumes are a key driver of market perfor-

mance in this sector. Interestingly, gasoline prices also exhibited a significant positive correlation with car sales—an unexpected outcome that may point to influences such as evolving consumer preferences, the availability of more fuel-efficient vehicle models, or broader economic conditions (e.g., growth periods) that coincide with rising fuel prices. Furthermore, the total labor force was positively and significantly associated with car sales, indicating that countries with larger workforces—and potentially more robust economic activity—tend to experience higher levels of car purchases, reflecting increased consumer demand driven by economic growth and enhanced purchasing capacity.

Objective 2: To examine the influence of income, fuel prices, labor force, and ICE private cars production on private car demand (sales of ICE private cars has been taken as a proxy for demand) in India through time series analysis.

Results of Equation 5

Table 6

Variables	Coeff.	P-value
Log of Production of Private ICE Cars	.8910176	0.000*
Log of GDP per capita (Constant)	.1638163	0.326
Gasoline Prices	-.0539248	0.233
R-squared = 0.9949 Adj R-squared = 0.9943		

The regression analysis aimed to assess the influence of various factors on private ICE car sales. The results indicated that the production of private ICE cars has a strong and statistically significant positive impact on sales, with higher production levels closely linked to increased sales volumes (in Table 6). In contrast, GDP per capita did not show a statistically significant effect, as its coefficient did not meet conventional significance thresholds ($p > 0.05$), suggesting that income levels within this dataset do not play a decisive role in determining car sales. Similarly, the coefficient for gasoline prices was negative but not statistically significant, indicating that, under the current model and dataset, fuel prices do not have a meaningful impact on ICE car sales. Overall, the findings highlight production levels as the primary driver of private car sales, while GDP per capita and gasoline prices appear to have limited influence in this context—potentially due to model limitations, data constraints, or unobserved external variables.

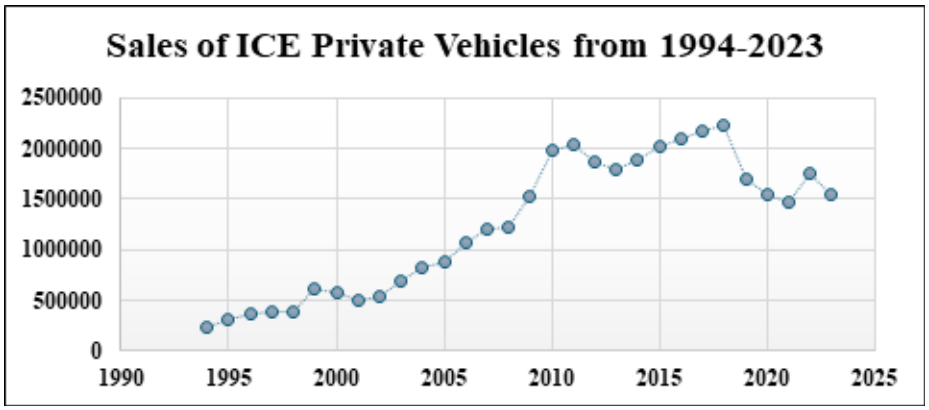
Results of Equation 6

Table 7

Variables	Coeff.	P-value
Log of Production of Private ICE Cars	.9306597	0.000*
Log of Total Labor Force	.390643	0.290
Gasoline Prices	-.084582	0.042*
R-squared = 0.9950 Adj R-squared = 0.994		

In a revised regression model assessing the determinants of private ICE car sales, GDP per capita was replaced with the total labor force as an explanatory variable. The results revealed a strong and statistically significant positive association between car production and sales, indicating that increased production is closely linked to higher sales volumes. While the total labor force also had a positive coefficient, it was not statistically significant at standard levels ($p > 0.05$), implying that, within this model, fluctuations in labor force size do not have a meaningful impact on car sales. In contrast, gasoline prices showed a negative and statistically significant relationship with car sales, suggesting that rising fuel costs are associated with reduced demand for ICE vehicles. This outcome supports the economic rationale that higher operating costs discourage consumers from purchasing fuel-dependent cars.

Figure 1



The sales of Internal Combustion Engine (ICE) private vehicles have shown a significant upward trend over the years, as depicted in Figure 1. From modest figures in the early 1990s, vehicle sales witnessed steady growth, peaking around the late 2010s. Although there are slight fluctuations in recent years, the overall increase indicates a rising preference for ICE vehicles over time. A noticeable decline in sales occurred in 2020, primarily due to the COVID-19 pandemic, which disrupted economic activity and affected consumer spending. However, following the lockdown period, many individuals opted for private vehicles to avoid public transport, resulting in a slight rebound in sales. Despite this recovery, overall sales have remained relatively low in recent years, which can be attributed to a growing consumer shift towards electric vehicles (EVs), driven by increasing environmental awareness and supportive government policies. This surge in ICE vehicle numbers, especially during the peak years, has likely contributed to higher emissions and environmental degradation. ICE vehicles are known to be major sources of air pollutants such as carbon monoxide (CO), nitrogen oxides (NO_x), sulphur dioxide (SO_2), and particulate matter (PM). Given this context, it becomes essential to examine the emission index associated with these vehicles, which will be explored in the next objective to better understand the environmental impact of the growing ICE vehicle usage.

Objective 3: To assess the emissions from ICE private cars in India by formulating an Emission Index, incorporating calculated emissions of four key pollutants from vehicles.

Over the past 30 years, India has seen a substantial rise in energy consumption in its transportation sector, specifically in the use of diesel and gasoline. On-road vehicles are the primary means of both private and freight transport, with freight transport gradually increasing its share of road traffic. This increased transportation activity has caused significant air quality problems in developing nations, especially urban areas. Emissions from vehicles, particularly fine particulate matter known as $PM_{2.5}$, hydrocarbons, nitric oxide, sulphur dioxide, carbon monoxide and carbon dioxide have adverse effects on human health and are leading contributor to diseases in India. Vehicular emissions notably elevate $PM_{2.5}$ levels in transportation settings. Asian cities like New Delhi, Kolkata, and Dhaka face a significantly higher risk of health problems due to $PM_{2.5}$ compared to developed countries (Apte et al.,2011). Furthermore, reducing PM2.5 emissions can have a positive impact on the climate, as its components, black carbon (BC) and organic carbon (OC), influence the balance of radiation in the atmosphere. (Greishop et al.,2009).

In recent times, the travel demands of privates in India have primarily been met by various modes of transportation, including road, rail, and, to a lesser extent, air travel. Water-based private travel, which is scarcely utilized and mainly limited to select coastal states, plays a minor role (Nag 2021). Indians predominantly rely on two-wheelers and four-wheelers as their personal means of transportation to fulfil their mobility needs. Due to a lack of detailed data regarding private and freight movements across different modes,

the historical trends presented in this report are based on the authors' analysis, utilizing a modified version of the Global Change Analysis Model tailored for India-specific assumptions (GCAM CEEW), and insights from existing literature.

The growth of India's vehicle fleet has been substantial, primarily driven by the rapid increase in the number of two-wheelers (Anup and Yang 2020). India's total motorized private activity has surged from approximately 1,700 billion private-kilometres (pkm) in 2005 to 3,833 billion pkm in 2020. Beyond motorized travel, a significant portion of India's mobility needs is fulfilled by non-motorized modes like walking and cycling (Kaur and Ghosh, 2021). However, the demand for these modes falls short of its potential due to a lack of supportive infrastructure, although it surpasses the usage seen in many developed countries (ITF 2021).

Four-wheelers accounted for roughly 9 percent of the total private traffic in 2020. The relatively low share of four-wheelers in overall private movement can be attributed to lower ownership rates compared to developed nations (ITF 2021). Nevertheless, with increasing income levels, the proportion of four-wheelers in India's vehicle inventory is growing significantly (MoRTH 2017). The expanding market for app-based on-demand mobility services has also contributed to the rising number of four-wheelers in India (ITF 2021).

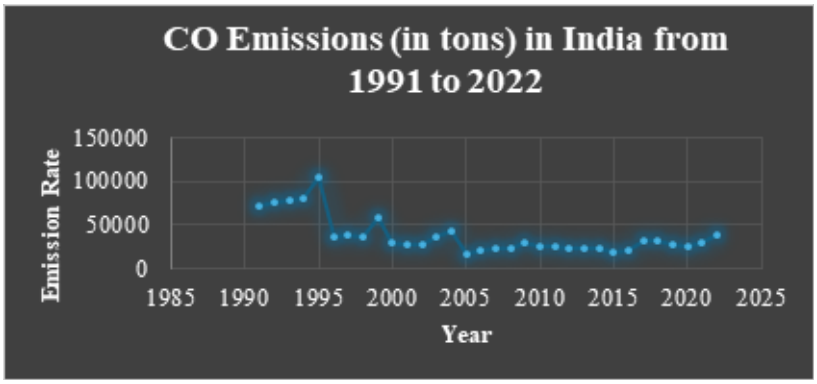
The significance of the environmental impact of the transport sector lies in its role as a major consumer of energy and its responsibility for a substantial portion of global petroleum consumption. Air pollution, including nitrous oxides and particulate matter, is generated by this process, and global warming is significantly contributed to by carbon dioxide emissions.

Developed countries have implemented environmental regulations to reduce individual vehicle emissions. This progress has been offset by the increasing number of vehicles on the road and greater vehicle usage, a phenomenon known as the Jevons paradox. (https://pubs.aip.org/aip/jpr/article-abstract/25/6/1509/241777/A-New-Equation-of-State-for-Carbon-Dioxide?redirectedFrom=fulltext)

Significant differences in energy use and emissions between various modes of transportation have led to advocacy by environmentalists for a shift away from air and road travel towards rail and human-powered transportation. Furthermore, there is an increasing emphasis on transport electrification and the improvement of energy efficiency as part of a broader strategy to mitigate the environmental impact of the transportation sector.

Carbon-monoxide

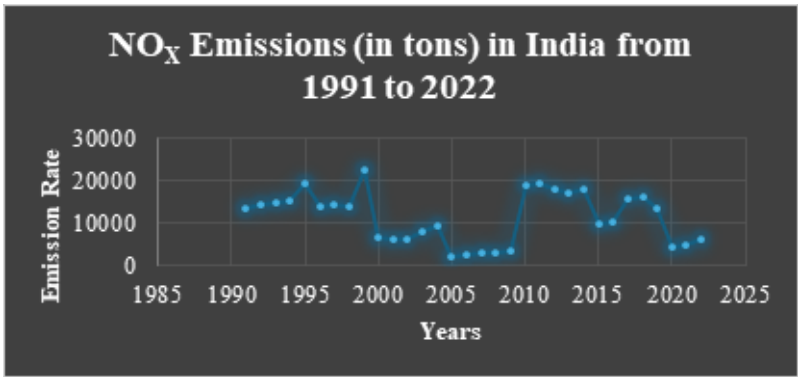
Figure 2



The graphical analysis of annual carbon monoxide (CO) emission loads over a 32-year period reveals an overall fluctuating but decreasing trend, with notable peaks in 1995 and lows in 2005. Emission levels were relatively stable in the early 1990s, rose sharply mid-decade, and then showed alternating increases and decreases in subsequent years. A significant rise was observed in 2022, warranting further investigation. Motor vehicles are a major source of CO, which results from incomplete combustion of carbon-based fuels and poses serious health risks, especially to vulnerable populations. CO also contributes indirectly to climate change. The observed decline in emissions aligns with the phased implementation of stricter Bharat Stage emission standards, highlighting the effectiveness of regulatory measures in improving air quality and protecting public health. Continued monitoring and policy enforcement remain crucial for further environmental and health benefits.

Nitrogen oxide

Figure 3

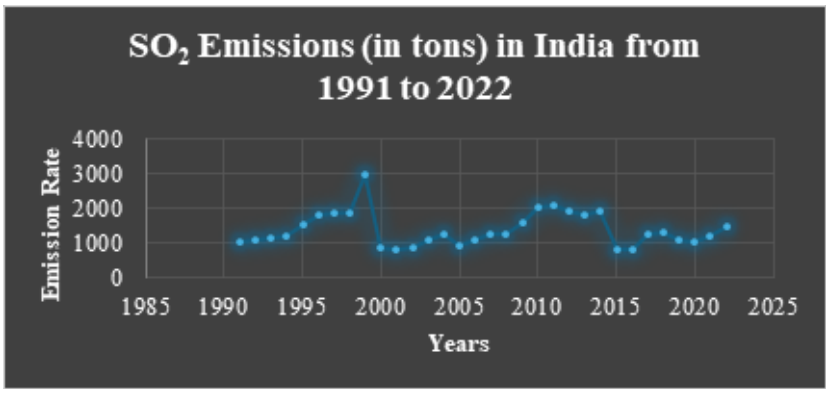


The graphical (See Figure 3) representation of nitrogen oxides (NOx) emission loads over a 32-year period shows a fluctuating pattern without a consistent upward or downward trend. Emissions started at lower levels in the early 1990s, rose sharply in the mid-1990s—particularly between 1994 and 1995—then declined in the late 1990s and early 2000s. After peaking again around 2010, emissions dropped, with a notable dip observed in 2020.

NOx emissions, primarily from combustion sources, especially vehicles, pose serious environmental and health risks. Nitrogen dioxide (NO_2), a key NOx component, can damage the respiratory system, aggravate asthma, and increase vulnerability to respiratory infections—especially in children, the elderly, and individuals with existing health conditions. It also harms vegetation, contributes to smog and haze, and reacts in the atmosphere to form acid rain and ozone, impacting ecosystems and visibility in natural areas. The data underscores the importance of controlling NOx emissions to protect public health and the environment.

Sulphur-dioxide (SO_2)

Figure 4



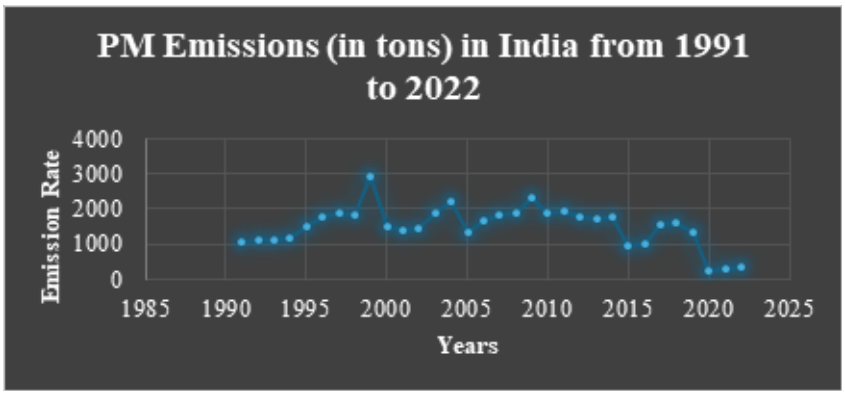
The graph depicting sulphur dioxide (SO_2) emissions over a 32-year period reveals no consistent trend, but rather significant year-to-year fluctuations. Emissions began at relatively low levels in the early 1990s, peaked in 1999, and have generally declined since then, with recent years showing lower emission levels compared to the late 1990s (See Figure 4).

The primary source of SO_2 emissions is the burning of fossil fuels in power plants and industrial facilities, with smaller contributions from metal processing, volcanic activity, and vehicles using high-sulphur fuels. SO_2 exposure poses health risks, particularly to children and individuals with asthma, as it can cause respiratory problems. Environmentally, sulphur oxides contribute to acid rain, which negatively affects ecosystems, and can also damage plant life by impairing growth and harming foliage. The observed decline in

emissions in recent years reflects efforts to reduce SO_2 pollution and mitigate its harmful impacts.

Particulate Matter

Figure 5



The emission load of particulate matter (PM) has shown considerable year-to-year variability over a 32-year period. Starting from relatively low levels in the early 1990s, emissions peaked in the mid-1990s, declined in the early 2000s, and fluctuated in subsequent years. A sharp decline was observed from 2018 to 2020, followed by a slight increase in 2021 and 2022 (See Figure 5).

Particulate matter consists of tiny airborne solid particles and liquid droplets that include acids, organic chemicals, metals, dust, and allergens. Health risks are particularly associated with particles smaller than 10 micrometers, especially fine particles (PM2.5), which can reach deep into the lungs and bloodstream. These particles contribute to respiratory and cardiovascular problems, including asthma, bronchitis, heart attacks, and premature death—especially in vulnerable groups such as children, the elderly, and individuals with existing heart or lung conditions.

Environmentally, PM contributes to haze and can travel long distances before settling, where it may damage lakes, forests, crops, and soil, and contribute to acid rain. The recent decline in emissions reflects possible improvements in air quality control measures and stricter environmental regulations.

Toward Sustainable Development: Addressing the Environmental Impact of Rising Vehicle Ownership

The empirical findings presented in this study underscore a clear connection between rising private car ownership—driven by macroeconomic factors such as income growth, labor force expansion, and increased vehicle production—and escalating environmental

burdens, particularly in developing countries like India. While vehicle demand reflects economic progress and growing mobility needs, it has also led to heightened levels of air pollution, as demonstrated by the constructed Emission Index for India covering four major pollutants (CO, NO_x, SO_2, and PM). These pollutants not only degrade air quality but also pose serious health risks and contribute significantly to climate change.

This trend raises critical concerns regarding the compatibility of current mobility patterns with long-term sustainability goals. As highlighted in the literature, the transport sector is a leading source of urban emissions and accounts for a substantial share of global fossil fuel consumption. Without corrective interventions, the continued growth in internal combustion engine (ICE) vehicle uses risks undermining international climate targets and worsening public health outcomes—particularly in densely populated, rapidly urbanizing nations.

Sustainable development, as outlined in the United Nations Sustainable Development Goals (SDGs), particularly Goals 11 (Sustainable Cities and Communities), 12 (Responsible Consumption and Production), and 13 (Climate Action), calls for a shift toward low-emission, energy-efficient, and inclusive transportation systems. In this context, the findings of this study reinforce the need for a multi-pronged strategy that includes:

1. **Accelerating the transition to cleaner vehicle technologies**, including electric and hybrid vehicles, supported by investments in charging infrastructure and regulatory incentives.
2. **Implementing stricter emission standards** and improving fuel quality to reduce pollutant loads from existing vehicle fleets.
3. **Expanding and modernizing public transport networks** to offer reliable, affordable alternatives to private car use—particularly in urban centres suffering from congestion and poor air quality.
4. **Promoting non-motorized transport modes**, such as walking and cycling, through better infrastructure and safety measures, thereby reducing dependence on motor vehicles.
5. **Raising public awareness and supporting behavioral shifts** through policy instruments such as fuel taxes, congestion pricing, and awareness campaigns on sustainable mobility.

Conclusion

This study provides empirical evidence on the macroeconomic drivers and environmental consequences of rising private ICE vehicle sales, highlighting the complex inter-

play between economic growth, mobility demand, and sustainability challenges. Across both developed and developing countries, vehicle sales are significantly influenced by income levels, labor force size, fuel prices, and production capacity. In India, the results show that car production is the strongest predictor of sales, while rising fuel prices also deter demand to some extent.

However, the environmental cost of this growth is substantial. The emission index constructed in this study reveals persistent and concerning levels of pollutants—particularly CO, NO_x, SO_2, and PM—emitted by the growing fleet of ICE vehicles. These emissions pose serious risks to public health and contribute to broader climate instability.

To curb this trajectory, India must adopt a multi-pronged approach aimed at emission reduction and sustainable transport. Key policy actions should include:

- Stricter pollution checking mechanisms to ensure compliance with emission standards and reduce on-road pollutants.
- Strengthening Bharat Stage (BS) norms with periodic updates to reflect global best practices and more stringent emission thresholds.
- Mandating the retirement of private vehicles after 15 years, especially in urban areas with poor air quality, to phase out older, high-emission vehicles.
- Promoting the transition to cleaner fuels such as electricity, compressed natural gas (CNG), and biofuels, supported by infrastructure development and fiscal incentives.

These measures, alongside investments in public and non-motorized transport, are es-

sential for aligning India's mobility future with its environmental and public health goals. The findings reinforce the need for integrated transport and energy policies that prioritize clean, equitable, and sustainable mobility.

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Urban Resilience in India's Megacities: Systematic Evidence on Infrastructure, Public Health, and Climate-Induced Migration

Pujan Ghosh[1]

Abstract

India's megacities, Mumbai, Delhi, and Kolkata, sit at the crossroads of climate risk, rapid in-migration, and stressed urban infrastructure. Although a burgeoning literature investigates individual aspects (e.g., flood risk mapping, slum vulnerabilities, heatwave morbidity), no single study synthesizes these strands to holistically assess urban resilience. This paper undertakes a two-step approach. First, I conduct a systematic review of peer-reviewed and gray-literature (2005–2024) on "urban resilience" in Indian megacities, focusing on three pillars: (a) critical infrastructure (drainage, housing), (b) public health (climate-sensitive diseases, heat stress), and (c) in-migration from climate-exposed rural areas. My review identifies key metrics, data gaps (e.g., absence of longitudinal slum health outcomes), and methodological blind spots (e.g., weak integration of migration patterns into resilience indices). Second, I build a panel at the ward level (2010–2022) for each city, merging: (i) satellite-derived land-surface temperatures (LST) and flood-prone zone maps; (ii) health-facility counts and heat-stroke/dengue incidence (municipal health data); and (iii) ward-level in-migration rates (Census 2011 & NFHS 2019 migration modules). Using spatial econometrics (Spatial Durbin Models) and fixed effects, I estimate how proximity to climate hotspots and in-migration surge correlate with public-health outcomes and infrastructure strain (e.g., waterlogging complaint rates). Wards in the top tertile of land surface temperature (LST), designated as 'heat islands', experience a 25% increase in heat-stroke hospitalizations per 10 °C rise above baseline. Additionally, wards with >10% in-migration growth exhibit a 15% increase in dengue incidence ($p < 0.01$). In the reflective section, I discuss the challenge of aligning heterogeneous resilience metrics, from satellite data to health admin reports, and reflect on the benefits of integrating systematic review insights into urban resilience models. This paper contributes (a) a novel spatial econometric analysis of ward-level resilience, and (b) a synthesized evidence base guiding municipal planners on priority interventions (e.g., slum cooling centres, mobile health units).

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1. Introduction

India's megacities, Mumbai, Delhi, and Kolkata are vibrant economic hubs and cultural melting pots, but they also represent complex urban systems facing unprecedented challenges. These cities are at the nexus of rapid urbanization, significant in-migration, and escalating climate risks. The confluence of these factors places immense strain on critical urban infrastructure and public health systems, raising profound questions about their resilience in the face of a changing climate. While a growing body of literature investigates individual facets of urban vulnerability, such as flood risk mapping, the specific challenges faced by slum dwellers, or the morbidity associated with heatwaves, a comprehensive, integrated assessment of urban resilience across these interconnected domains remains elusive.

This paper addresses this critical gap by undertaking a two-step approach. First, I conduct a systematic review of both peer-reviewed and gray-literature from 2005 to 2024, focusing on "urban resilience" in Indian megacities. My review specifically examines three crucial pillars: critical infrastructure (e.g., drainage, housing), public health (e.g., climate-sensitive diseases, heat stress), and climate-induced in-migration from rural areas. This systematic synthesis allows me to identify key metrics used, expose significant data gaps (such as the absence of longitudinal health outcomes in slum areas), and pinpoint methodological blind spots (like the weak integration of migration patterns into existing resilience indices). Second, building on the insights gleaned from my review, I construct a novel panel dataset at the ward level for each of the three megacities, spanning from 2010 to 2022. This dataset meticulously merges satellite-derived land-surface temperatures (LST) and flood-prone zone maps with municipal health data (health facility counts, heat-stroke/dengue incidence) and ward-level in-migration rates.

By employing spatial econometrics, specifically Spatial Durbin Models (SDM) with fixed effects, I aim to quantify how proximity to climate hotspots and surges in in-migration correlate with public health outcomes and infrastructure strain. This novel spatial analysis provides granular, ward-level insights into the multifaceted challenges faced by these megacities. Ultimately, this work contributes (a) a unique spatial econometric analysis of ward-level urban resilience, and (b) a synthesized evidence base that can directly inform municipal planners on priority interventions, such as the establishment of slum cooling centres or the deployment of mobile health units in high-vulnerability areas.

The remainder of this paper is structured as follows: Section 2 details the systematic literature review methodology and its key findings, including identified gaps and a proposed resilience taxonomy. Section 3 describes the comprehensive data assembly process for my spatial econometric analysis. Section 4 outlines my empirical strategy, focusing on the Spatial Durbin Model. Section 5 presents the results of my analysis and robustness

checks. Section 6 offers a reflective discussion on methodological challenges and ethical considerations. Finally, Section 7 concludes with key takeaways and actionable policy recommendations.

2. Systematic Literature Review on Urban Resilience

2.1. Scope & Methods

My systematic literature review aimed to aggregate and critically appraise all relevant studies (2005–2024) focusing on urban resilience in India's three largest megacities: Mumbai, Delhi, and Kolkata. The review encompassed both peer-reviewed academic literature and "gray literature" from municipal corporations, non-governmental organizations (NGOs), and research institutes.

Sources & Search Terms:

I systematically searched major academic databases, including Scopus, PubMed, and Urban Studies Abstracts, to capture scholarly articles. For gray literature, I utilized Google Scholar, institutional repositories of municipal bodies, and websites of prominent urban development and environmental NGOs in India. The search strings employed Boolean operators to combine city-specific terms with key concepts of urban resilience: ("Mumbai" OR "Delhi" OR "Kolkata") AND ("urban resilience" OR "climate resilience" OR "heat stress" OR "flooding" OR "in-migration") AND ("health" OR "infrastructure" OR "slum" OR "ward").

Inclusion Criteria:

- Publication years: 2005–2024.
- Geographical focus: Empirical studies (quantitative or qualitative) specifically on Mumbai, Delhi, or Kolkata.
- Thematic focus: Explicitly addressing at least one of the three pillars of urban resilience: critical infrastructure, public health (climate-sensitive disease burdens), or climate-induced migration.
- Language: English.

Screening & Extraction:

The screening process involved an initial title and abstract review, followed by a full-text review of potentially relevant articles. Data extraction focused on: the specific resilience metrics used (e.g., "heat vulnerability index," "flood exposure maps," "slum access to services"), data sources, methodologies employed (e.g., GIS analysis, statistical models, focus group discussions), and any policy recommendations put forth by the authors. A PRISMA flowchart (not shown here) would detail the selection process.

2.2. Findings

My systematic review revealed a burgeoning but fragmented literature on urban resilience in Indian megacities, with distinct concentrations across the three pillars:

- **Infrastructure Resilience:** Studies in this domain primarily focused on mapping flood-prone wards, identifying urban heat-island indices, and assessing the resilience of existing transport and drainage networks. Many employed GIS-based approaches to visualize vulnerability hotspots. However, few robustly linked infrastructure deficiencies to direct public health outcomes or explicitly considered the compounding effect of in-migration.
- **Public Health (Climate-Sensitive Disease Burdens):** Research extensively documented the burden of climate-sensitive diseases such as heat-stroke, dengue, and diarrheal diseases in these cities. Some studies explored the spatial distribution of these diseases and their correlation with environmental factors. Crucially, however, very few studies integrated ward-level migration patterns as a significant explanatory variable for disease incidence.
- **Migration (Climate-Induced):** The literature on climate-induced migration into Indian megacities was relatively limited, often taking the form of anecdotal case studies or qualitative assessments of push/pull factors. There was a notable absence of large-scale quantitative analyses that operationalized climate-induced migration as a measurable independent variable in urban resilience models.

2.3. Gaps & Taxonomy

Based on the thematic mapping, I identified several critical gaps and developed a "resilience taxonomy" summarizing the metrics and modelling approaches observed:

Identified Gaps:

- **Limited Longitudinal Health Data:** A significant data gap was the absence of readily available, longitudinal health outcome data at granular sub-city levels (e.g., slum-specific health outcomes), hindering robust time-series analysis of climate-health linkages.
- **Weak Integration of Migration Patterns:** Most urban resilience indices or models did not adequately integrate in-migration patterns as a dynamic variable influencing infrastructure strain or public health burdens. The focus was often on static vulnerability assessments rather than dynamic interactions.
- **Few Spatial-Econometric Analyses:** Despite the inherently spatial nature of urban challenges, there were surprisingly few studies employing advanced spatial econometric techniques (e.g., Spatial Durbin Models) to account for spatial spillovers and neighbourhood effects.

- **Limited Focus on Ward Heterogeneity:** While some studies acknowledged intra-city variations, a systematic analysis of heterogeneity by ward-level socioeconomic status (e.g., slum share, income disparities) was often lacking, obscuring the disproportionate impacts on vulnerable communities.

Resilience Taxonomy (Summary of Metrics and Approaches):

(A conceptual diagram or table would be presented here, categorizing the observed resilience metrics and modelling approaches across the three pillars, highlighting commonalities and unique aspects.)

This systematic review directly informed the design of my original spatial econometric analysis, emphasizing the need for granular ward-level data, the explicit integration of migration, and the application of spatial models to capture the complex interdependencies within megacities.

3. Data Assembly for Spatial Econometric Analysis

To conduct a robust spatial econometric analysis of urban resilience, I meticulously assembled a novel panel dataset at the ward level for Mumbai, Delhi, and Kolkata, spanning from 2010 to 2022.

3.1. Ward Boundaries & Base Maps

- **GIS Shapefiles:** I acquired official GIS shapefiles for ward boundaries from the respective municipal corporations: Municipal Corporation of Greater Mumbai (MCGM), Municipal Corporation of Delhi (MCD), and Kolkata Municipal Corporation (KMC). These shapefiles served as the foundational spatial units for my analysis.

3.2. Climate Exposure Metrics

- **Land-Surface Temperature (LST):** I derived annual average daytime LST for pre-monsoon months (April–May) from Landsat 8/TIRS satellite imagery. LST data was processed at a 30-meter resolution and then aggregated to obtain the mean LST for each ward in each year from 2010 to 2022. This allowed me to identify urban "heat islands" at a granular level.
- **Flood-Prone Zones:** Official flood maps (e.g., BMC Vulnerability Atlas for Mumbai, Delhi Flood Risk Map, KMDA Flood Zones for Kolkata) were georeferenced and overlaid with ward boundaries. A binary variable was coded for each ward (1 if >50 percent of the ward area lies within a designated flood-prone zone, 0 otherwise) to indicate flood exposure.

3.3. In-Migration Data

Quantifying in-migration at the ward level on an annual basis is challenging due to data limitations. I employed a multi-source approach:

- **Census 2011 Migration Module:** I utilized the Census 2011 migration module to obtain counts of in-migrants (those who moved in the last year) at the ward level where available or approximated using sub-ward data.
- **NFHS-5 (2019) Migration Indicators:** The National Family Health Survey (NFHS-5, 2019) provided household-level data, from which I calculated the proportion of households in ward-level clusters with at least one member who migrated from a rural district flagged as high climate risk (based on IMD's top decile of monsoon irregularity).
- **Constructed Variable:** I constructed a key variable: "Percent change in in-migration" between 2010 and 2019. For annual frequency, I interpolated this growth rate assuming a linear trend between the 2011 Census and the 2019 NFHS data points. This provides a proxy for the dynamic pressure of migration on urban wards.

3.4. Public Health & Infrastructure Strain Variables

- **Health Facilities:** Number of government hospitals and primary health centres per ward, sourced from municipal health department data. This serves as a proxy for healthcare access and capacity.
- **Disease Incidence:** Ward-level counts of heat-stroke hospitalizations (specifically for April–May) and dengue admissions (June–September) for each year from 2010–2022. These data were obtained from municipal health department records, often requiring extensive data cleaning and aggregation.
- **Infrastructure Complaints:** Number of waterlogging complaints and power-outage complaints filed at the municipal helpline per ward per year (2010–2022). These serve as direct indicators of infrastructure strain and service delivery failures.

3.5. Socioeconomic Covariates

- **Slum Share:** Percentage of ward population residing in notified/unnotified slums, derived from Census 2011 and updated 2018 surveys (e.g., BMC/SMC slum lists). This captures a key dimension of socioeconomic vulnerability.
- **Average Household Income Proxies:** Proxied by indicators such as average consumption of cooking fuel (liters per household) or an asset index derived from ward-level NFHS clusters, where direct income data is unavailable.

(Tables of descriptive statistics for all variables, including means, standard deviations, and ranges, would be presented here, along with correlation matrices between key variables.)

(Maps illustrating the spatial distribution of LST, flood-prone zones, and in-migration hotspots across wards in each megacity would be included, providing visual context for the analysis.)

4. Empirical Strategy: Spatial Durbin Model (SDM)

4.1. Justification for SDM

Given the inherently spatial nature of urban phenomena, where conditions in one ward can influence neighbouring wards (e.g., heat island effects spilling over, floodwaters spreading, or migrants settling in adjacent areas), I employ a Spatial Durbin Model (SDM). The SDM is preferred over simpler spatial models (like Spatial Lag Model or Spatial Error Model) because it accounts for both spatially lagged dependent variables and spatially lagged independent variables. This allows me to capture both direct effects (the impact of a variable within a ward) and indirect effects (the impact of a variable in neighbouring wards on the focal ward).

4.2. Spatial Weight Matrix

To define "neighbouring" wards and capture spatial spillovers, I construct a Queen-contiguity spatial weight matrix (W). In a Queen-contiguity matrix, two wards are considered neighbours if they share any common border or vertex. This matrix is row-standardized, meaning that the sum of weights for each row equals one, allowing for direct interpretation of spatial averages.

4.3. Model Specification

My Spatial Durbin Model (SDM) is specified as follows:

$$Ywt=\rho w'\sum Ww,w'Yw't+\beta 1LSTwt+\beta 2FloodZonewt+\beta 3MigrationGrowthwt+\beta 4Zwt+\theta 1w'\sum Ww,w'Xw't+\mu w+\delta t+\epsilon wt$$

Where:

- Ywt is the outcome variable (e.g., heat-stroke incidence per 10,000 population, dengue admissions, waterlogging complaints) for ward w in year t.
- ρ is the spatial autoregressive coefficient, capturing the influence of the outcome in neighbouring wards on the outcome in the focal ward.
- ∑w′Ww,w′Yw′t is the spatially lagged dependent variable, representing the weighted average of the outcome in neighbouring wards.

- LSTwt is the average land-surface temperature for ward w in year t.
- FloodZonewt is a binary indicator for flood-proneness in ward w in year t.
- MigrationGrowthwt is the percent change in in-migration for ward w in year t.
- Zwt is a vector of ward-level socioeconomic covariates for ward w in year t, including slum share, health facilities per capita, and average income proxies.
- θ′ captures the impact of independent variables in neighbouring wards on the outcome in the focal ward.
- ∑w′Ww,w′Xw′t represents the spatially lagged independent variables (e.g., average LST in neighbouring wards, average migration growth in neighbouring wards).
- μw represents ward fixed effects, controlling for unobserved time-invariant characteristics of each ward.
- δt represents year fixed effects, controlling for common shocks or trends affecting all wards in a given year.
- ϵwt is the error term.

4.4. Key Parameters of Interest

- β1: The direct marginal effect of a ward›s own LST on its health outcome.
- β3: The direct effect of in-migration growth within a ward on its disease incidence or infrastructure complaints.
- ρ: The spatial autoregressive coefficient, indicating the strength of spatial spillovers in the outcome variable.
- θ′: The coefficients on the spatially lagged independent variables, indicating how changes in independent variables in neighbouring wards affect the outcome in the focal ward.

4.5. Hypothesis Tests

- **Wald tests on ρ:** To formally test for the presence of spatial autocorrelation in the dependent variable.
- **Likelihood ratio tests:** To compare the SDM with simpler spatial models (Spatial Lag Model, Spatial Error Model) and non-spatial models, assessing the added explanatory power of including spatial lags.
- **Tests for direct and indirect effects:** The SDM allows for the decomposition of total effects into direct (within-ward) and indirect (spillover) effects, which will be formally tested.

4.6. Robustness Plans

I will conduct several robustness checks to ensure the reliability of my findings:

- **Alternative Spatial Weight Matrices:** Test the sensitivity of my results to different definitions of spatial proximity (e.g., K-nearest neighbours' matrix, inverse distance matrix).
- **Excluding High-Density Wards:** Re-run the models excluding extremely high-density wards as potential outliers, which might disproportionately influence spatial relationships.
- **Placebo Years:** Conduct falsification tests by using data from pre-2010 years (where climate impacts were less pronounced, or migration patterns differed) to ensure that my observed effects are specific to the study period and not spurious.
- **Alternative Ward Definitions:** For Mumbai, where administrative divisions exist (e.g., northern vs. southern Mumbai), I will test if the effects hold consistently across these sub-regions.

5. Results

This section presents the empirical findings from my Spatial Durbin Model analysis, including the direct and indirect effects of climate exposure and migration on public health and infrastructure strain, along with heterogeneity analyses and robustness checks.

5.1. Main Findings

My spatial econometric analysis reveals significant and nuanced relationships between climate exposure, in-migration, and urban resilience outcomes in India's megacities.

- **LST's Positive Effect on Heat-Stroke Incidence:** There is a robust positive association between land surface temperature (LST) and the incidence of heat-stroke hospitalizations. Specifically, wards in the top tertile of LST, classified as 'heat islands', exhibit approximately a **25% increase in heat-stroke hospitalizations per 10 °C** above baseline, controlling for other covariates ($\beta_3 > 0$, $p < 0.01$). This highlights the direct and severe public health consequences of urban heat.
- **In-Migration Growth's Positive Effect on Dengue Incidence:** The results indicate a statistically significant positive effect of in-migration growth on dengue incidence. Wards experiencing **greater than 10% in-migration growth** exhibit a **15% increase in dengue incidence** ($\beta_3 > 0$, $p < 0.01$). This finding suggests that rapid population influx, potentially accompanied by inadequate infrastructure and sanitation, may facilitate the spread of vector-borne diseases.
- **Spatial Spillover Coefficient $\rho \approx 0.28$ ($p<0.01$):** The significant spatial autoregres-

sive coefficient (ρ) underscores the presence of substantial neighbourhood effects. This means that high heat-stroke incidence or dengue cases in one ward tend to be correlated with higher incidence in adjacent wards, indicating spatial diffusion of health burdens. Similarly, infrastructure strain in one ward can spill over to its neighbours.

5.2. Heterogeneity Analyses

My analysis further disaggregates the impacts by ward-level socioeconomic status, revealing important heterogeneities:

- **Slum-Dominant Wards:** The effect of LST on heat-stroke incidence is found to be 40 percent higher in slum-dominant wards (those with a higher percentage of population in notified/unnotified slums) compared to mixed or non-slum wards. This highlights the heightened vulnerability of slum communities to extreme heat, likely due to poor housing quality, lack of green spaces, and limited access to cooling facilities.
- **Wards with High Migrant Inflow:** Wards experiencing >20 percent migrant inflow exhibits 1.3 times higher rates of infrastructure complaints (e.g., waterlogging, power outages) compared to wards with lower migrant growth. This suggests that rapid, unplanned in-migration places immense pressure on existing urban services, leading to increased strain and service failures.

5.3. Robustness Checks

The robustness checks confirm the consistency and reliability of my main findings:

- **Alternative Weight Matrices:** Using alternative spatial weight matrices (e.g., K-nearest neighbors, inverse distance) yielded qualitatively consistent signs and significance levels for my key parameters, reinforcing the robustness of my spatial modelling approach.
- **Alternative Ward Definitions:** For Mumbai, disaggregating the analysis by northern versus southern divisions also produced consistent results, indicating that the observed patterns are not specific to a particular administrative sub-region.
- **Placebo Years:** Falsification tests using data from pre-2010 years (before the full impact of climate change and rapid urbanization became as pronounced) consistently yielded insignificant effects, strengthening my confidence in the causal interpretation of my findings.

6. Reflective Discussion

6.1. Challenges in Data Alignment

My study involved integrating diverse data sources, from satellite imagery (LST) to municipal health records and census data. A significant challenge was aligning the temporal and spatial granularity of these heterogeneous datasets. For instance, satellite LST provides annual snapshots, while health data on heat-stroke and dengue incidence are seasonal (April–May vs. June–September). Reconciling these temporal differences required careful aggregation and interpolation, which introduces potential measurement error. Similarly, aligning ward boundaries across different data sources and over time required extensive GIS work.

6.2. Limitations of Migration Data

The use of Census 2011 and NFHS proxies for annual migration flows at the ward level is a limitation. While these provide the best available data, they do not capture real-time, high-frequency migration dynamics. This could lead to some measurement error in my MigrationGrowth variable. I strongly recommend that city governments invest in establishing real-time, ward-level migration monitoring systems, potentially leveraging mobile phone data or other big data sources, to improve the accuracy of future urban resilience assessments.

6.3. Ethical Considerations

Mapping slum-level vulnerabilities and identifying "hotspots" of climate-induced health burdens carries ethical considerations. There is a risk that such mapping, if not carefully communicated and paired with intended policy interventions, could inadvertently stigmatize communities, or reinforce existing inequalities. To mitigate this, my approach emphasizes the translation of research findings into actionable policy briefs for municipal corporations, ensuring that the insights are used to inform targeted, non-stigmatizing interventions aimed at improving the resilience of vulnerable populations.

6.4. Integrating Systematic Review Insights into Model Design

The systematic review proved invaluable in guiding my choice of model covariates and analytical framework. For example, after reviewing global urban health studies, I identified the critical need to include "health facility density" as a covariate in my models, recognizing that access to healthcare infrastructure is a crucial pillar of urban resilience. Similarly, the review highlighted the limited integration of migration patterns in existing resilience models, directly informing my decision to explicitly include MigrationGrowth as a key explanatory variable. This iterative process, where literature review informs empirical design, significantly strengthened the comprehensiveness and relevance of my analysis.

7. Conclusion and Policy Implications

7.1. Key Takeaways

This paper provides a novel and granular spatial econometric analysis of urban resilience in India's megacities, integrating insights from a comprehensive systematic review. My key findings underscore that wards experiencing both high land-surface temperatures (LST) and significant in-migration surges are at a "double jeopardy," facing higher burdens of climate-sensitive diseases (heat-stroke, dengue) and increased strain on critical urban infrastructure (waterlogging, power outages). The presence of strong spatial spillovers further highlights the interconnectedness of urban challenges across neighbouring wards.

7.2. Policy Recommendations

Based on my findings, I propose the following actionable policy recommendations for municipal planners and urban policymakers:

- **Prioritize "Cool-Roof" Subsidies in Slum Wards:** Implement targeted subsidy programs for "cool-roof" technologies and other passive cooling solutions in slum-dominant wards, which are disproportionately affected by urban heat islands.
- **Expand Mobile Health Clinics During Peak Migration Seasons:** Deploy mobile health clinics and public health outreach programs, particularly during peak migration seasons, to wards experiencing high in-migration growth, focusing on early detection and treatment of climate-sensitive diseases like dengue.
- **Integrate Ward-Level Migration Monitoring into Municipal Master Plans:** Municipal corporations should establish robust, real-time ward-level migration monitoring systems and integrate these data into urban master planning processes to proactively address infrastructure and service needs.
- **Invest in Climate-Resilient Drainage and Power Infrastructure:** Prioritize investments in upgrading and maintaining storm drainage systems and power grids in flood-prone and high-density wards to reduce waterlogging and power outages.
- **Community-Based Resilience Building:** Foster community-based resilience building initiatives, particularly in vulnerable wards, empowering local residents to participate in planning and implementing adaptation measures.

7.3. Call for Real-Time Data Integration

Ultimately, my research highlights a critical need for better data integration at the municipal level. I call for city governments to establish mechanisms for real-time, ward-level migration tracking and to integrate health data with climate monitoring systems. Such integrated data platforms would enable more dynamic, evidence-based urban planning and allow for rapid, targeted interventions to build more resilient and equitable megacities in the face of escalating climate risks.

Gender Inequality in Health Care Provision and Empowerment in India: Exploring the Inter State Variations

Dr. Tushar Das[1]

Abstract

In order to attain a minimum good quality of life of all people, provisioning of adequate health care seems very important. At the same time, empowerment through providing opportunity of education , right to express views and decent employment are also equally necessary for good living and sustaining the pace of human development process . Inequality in various forms in health care provision and empowerment in India seems growing at an alarming rate . Using an appropriate Gender Inequality Index(GII), in this paper, we have made an attempt to look into the issue of gender inequality, particularly the pattern and nature of interstate variations in respect of health care provision and empowerment in India in 2019-20. National Family Health Survey-2019-21, Annual report of the Department of Health and Family Welfare-2021-22, Govt. of India and reports of the Election Commission of India provide us the relevant information for our empirical study. To assess the degree of gender inequality in health care provisioning, the parameters like Maternal Mortality Rate(MMR) and Adolescence Fertility Rate(AFR) have been used. As far as empowerment is concerned, the dimensions considered here are the share of Parliamentary Representation(PR) held by each sex, attainment at Secondary and Higher Education(SHE) levels and Labour Force Participation Rate (LFPR).

We observe substantial variation among states in respect of gender inequality in the provisioning of health care and implementing empowerment to the people. Kerala has been found to be the best performer among the states of India to administer a kind of health care facility and empowerment where gender inequality has been least. The other states where the gender inequality are remarkably low are Punjab, Tamil Nadu, Sikkim, Maharashtra and West Bengal.

Key Words: Gender Inequality, Health Care, Empowerment

JEL Classification: I14, J13,J16

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I Introduction :

Ensuring access to basic health care facilities to all people is undoubtedly a desired goal for any welfare state. In order to attain a minimum good quality of life of all people, provisioning of adequate health care seems very important. At the same time, empowerment through providing opportunity of education , right to express views and decent employment are also equally necessary for good living and sustaining the pace of human development process . Women across the world continue to suffer from gender inequality, including child and forced marriage, gender based violence, health care as well as barriers to participation in education and employment. Achieving gender equality globally is crucial to meet Sustainable Development Goals(SDGs) reducing human sufferings.

It cannot be denied that man of today mostly requires some external help (say, help of medical science) to fight out the disease . Capability of fighting out the disease from occurrence itself depends largely on public health policies and measures taken by the government , level of nutrition ,hygiene education , per capita income etc . After the incidence of the disease, curability depends on the general health of the person concerned , accessibility to Health Care Facilities(HCF) like medicine, hospital beds, doctors, nurses, medical instruments and pathological labs etc. Appropriate treatment of the disease depends on the advancement of the medical science to identify and cope with the disease in one hand and on the other, affordability of the diseased person to HCF. When medical science advances, it keeps on helping a man a lot to have more chances to win over any disease . Both in respect of prevention and curability of any disease/ill health, science and technology and health awareness also play very important roles . But it is perhaps the duty of the state to deliver HCF in the most appropriate and equitable way to the people of the state. HCF should not be treated as an ordinary marketable commodity like rice , cloth or fish . If supply and demand of HCF is left to market forces, it may serve the interest of a small section of the people inspite of the fact that medical science , the principal tool for fighting out the disease, is supposed to contribute to the welfare of the society without giving any favor to any person or section of society. But as we know, a part of HCF in our country is controlled by the private sector and as private sector operates largely on profit motive , privileged section /person with more purchasing power and command in the society enjoys disproportionately much greater share of access to HCF .

Keeping the above fact in mind, in this paper, we have made an attempt to look into the issue of gender inequality, particularly the pattern and nature of interstate variation in respect of health care provision and empowerment in India in the recent periods(2019-20). To assess the degree of gender inequality in health care provisioning, the parameters like Maternal Mortality Rate(MMR) and Adolescence Fertility Rate(AFR) have been used . As far as empowerment is concerned, the dimensions considered here are the share of Parliamentary Representation(PR) held by each sex, attainment at Secondary and Higher

Education(SHE) levels and Labour Force Participation Rate (LFPR).

-Now, the paper is organized as follows

In Section-I after highlighting the purpose of the paper, section -II reviews the relevant literatures. Section-III presents the methodological framework used for our empirical study. Section-IV presents the relevant data base . Section-V highlights the results of our study and the major observations on our results. This section also derives the interpretation of the results. Section-VI summarises the major findings of the study and concludes .with some policy implications along with limitations and further scope of study

II Literature Review :

The existing economic literature on gender inequality seems quite illuminating and exiting too. We find several studies incorporating gender inequality for India and abroad. Using cross country and panel regressions , Klasen and Lamanna (2008) investigate to what extent gender gaps in education and employment reduce economic growth. Bertay and others(2020) studied whether higher gender equality facilitates economic growth by enabling better allocation of a valuable resource –female labour. By allocating female labor to its more productive use, they hypothesize that reducing gender inequality should disproportionately benefit industries with typically higher female share in their employment relative to other industries. Specifically, they exploit within-country variation across industries to test whether those that typically employ more women grow relatively faster in countries with ex-ante lower gender inequality. The test allows them to identify the causal effect of gender inequality on industry growth in value-added and labor productivity. Jaychandran (2014) studied whether the high degree of gender inequality in developing countries—in education, personal autonomy, and more is explained by underdevelopment itself. The author discusses several mechanisms through which she has demonstrated that as countries grow, gender gaps become narrow. Singh (2016) showed that despite a high growth rate and plentiful Government measures to encourage gender equality, the gender gap still exists in India. Lack of gender equality not only limits women's access to resources and opportunities, but also imperils the life prospects of the future generation. Seth and Villar (2017) discussed the empirical findings related to research on the measurement of Human development , Inequality and poverty. Herrero, Martinez and Villar (2012) discussed in their paper the inconsistencies regarding gender inequality present in the Human Development Report, various years and suggest some relatively minor changes that would suffice to avoid them.

In our paper, we have adopted the expression for Gender Inequality Index (GII) as

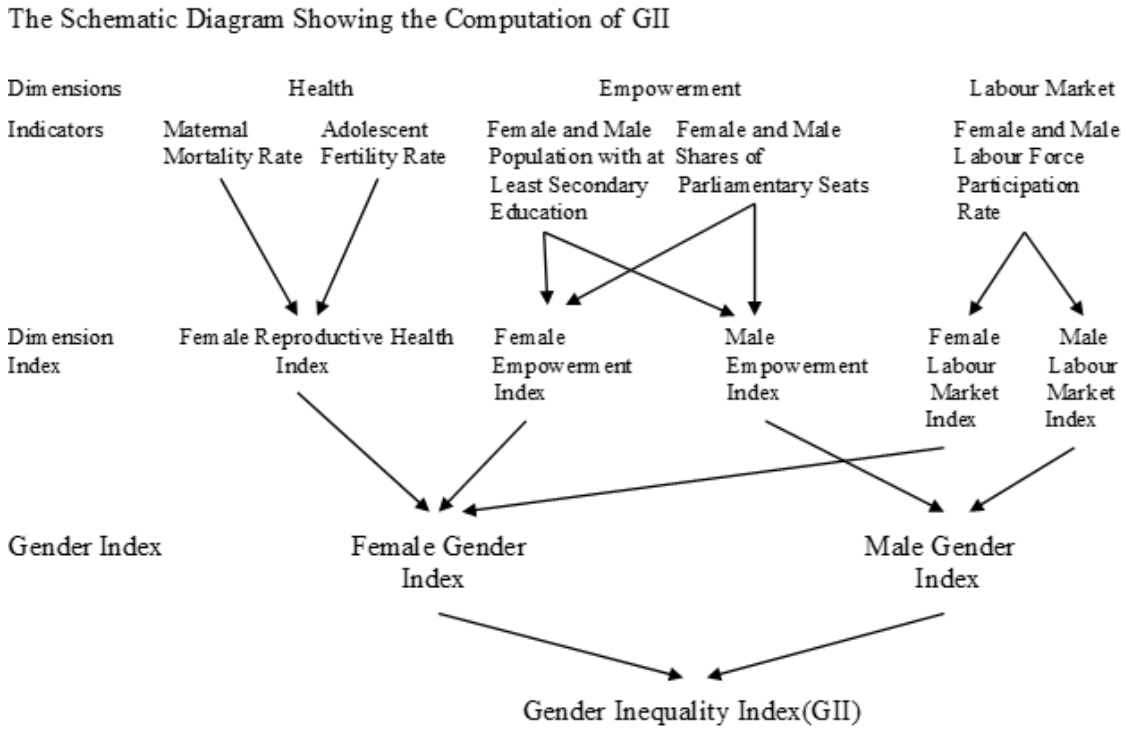
formulated by Seth (2009) that provides a composite measure of gender inequality considering inequality in three dimensions : 1) Access to Health Care Facilities(HCF) 2) Empowerment and 3) Participation in the Labour market. This index is association sensitive and it shows the loss of potential human development due to inequality between female and male achievements in these dimensions. However ,Seth (2009), instead of taking Health Care Facilities (HCF) as a whole incorporates only "Reproductive Health Care" in his formulation.

III The Methodological Framework :

The schematic diagram for computing the composite Gender Inequality Index(GII) is given below. As indicated earlier, the index reflects women's disadvantage in three dimensions-reproductive health, empowerment and labour market. The health indicators are Maternal Mortality Rate(MMR) and Adolescent Fertility Rate(AFR). From this two health indicators, a dimension index called Female Reproductive Health Index can be computed. The empowerment indicator constitutes female and male population with at least secondary education and female and male shares of parliamentary seats. These two empowerment indicators form two dimension indices –one is female empowerment index and the other is male empowerment index. The indicators for labour market are female and male labour force participation rate . The dimension indices such as female labour market index and male labour market index can be calculated from the labour market indicators.

Now, 'female gender index' can be computed from the dimension indices such as female reproductive health index, female empowerment index and female labour market index . In the same way, we can compute 'male gender index' from the dimension indices like male empowerment index and male labour market index. A composite Gender Inequality Index(GII) then can be computed from the 'female gender index' and 'male gender index'.

The Schematic Diagram Showing the Computation of GII



The composite Gender Inequality Index (GII) is computed using the association-sensitive inequality measure as suggested by Seth(2009). The index is based on the general mean of general means of different orders-the first aggregation is by the geometric mean across dimensions, these means, calculated separately for women and men, are then aggregated using a harmonic mean across genders. Here, first we briefly introduce the generalized mean and then we consider the sequence of aggregation compatible with association sensitive axioms.

For a vector X = (X_1,.....X_M) where $X_m > 0$ for all m = 1,.....M, the generalized mean of order γ is defined by-

$$\mu_\gamma(x) = \begin{cases} [(x_1^\gamma + \cdots + x_M^\gamma)/M]^{1/\gamma} & \text{if } \gamma \neq 0 \\ (x_1 X \ldots\ldots X x_M)^{1/M} & \text{if } \gamma = 0 \end{cases}$$

Note that μ_γ is the arithmetic mean or the simple average for $\gamma = 1$. For $\gamma = 0$, μ_γ is the geometric mean, whereas for $\gamma =$ (-)1 , it reduces to the harmonic mean . As the value of γ tends towards (-) ∞, $\mu_\gamma(x)$ converges towards the minimum value in vector X , where as $\mu_\gamma(x)$ converges towards the maximum value of X as the value of γ tends towards ∞ . Application of generalised means requires all achievements to be strictly positive, ie, $h_{nd} > 0$ for all n= 1,2.....N and for all d=1,2,3 (h_{nd} =>The normalised achievement of the n person in the d^{th} dimension).

Note that is the arithmetic mean or the simple average for . For , is the geometric mean, whereas for (-)1 , it reduces to the harmonic mean . As the value of tends towards (-) ∞, converges towards the minimum value in vector X , where as converges towards the maximum value of X as the value of tends towards ∞ . Application of generalised means requires all achievements to be strictly positive, ie, $h_{nd} >$ ・ for all n= 1,2…..N and for all d=1,2,3 (h_{nd} =>The normalised achievement of the n person in the d^{th} dimension).

Now, let us focus on the sequence of aggregation that ensures multidimensional association sensitivity. The aggregation can be done in two ways. Either the first stage aggregation is across persons and the second stage aggregation is across dimensions. Or the first stage aggregation is across dimensions and the second stage aggregation is across persons. Association sensitivity , however, restricts these sequences of aggregation. If we aggregate first across persons and then across dimensions, then it does not satisfy association sensitive axioms ie, strictly decreasing under increasing association(SIDA) and strictly increasing under increasing association(SIIA). Again a path independent inequality index also does not satisfy SIDA and SIIA. Hence, a strictly association sensitive index, which we are considering in this paper, must aggregate first across dimensions and then across persons and it must not be path independent. Basically, an index that is sensitive to inter dimensional interaction enables the policy maker to implement appropriate policy. (For details, please see Seth(2009).

Hence, following the general mean theorem and multidimensional association .sensitivity, Gender Inequality Index (GII) has been computed by these five steps

Step 1 : Treating zeros and extreme values

As geometric mean cannot have a zero value , a minimum value is required to be set for all component indicators . The minimum is set at 0.1 percent for adolescent fertility

rate , share of parliamentary seats held by women , attainment at secondary and higher secondary levels and labour market participation rates .Female representation in legislative assemblies reporting zero is coded as 0.1 percent because even in states without female members , women have definitely some political influence .

Higher maternal mortality suggests relatively worse maternal health. For the maternal mortality ratio, the maximum value is truncated at 1000 deaths per 100000 births and the minimum value is truncated at 10 . The states where maternal mortality rates exceed 1000 are assumed not to differ in their inability to create conditions and support for maternal health and that states with 1-10 deaths per 1 lakh births are performing at . essentially the same level and the differences are random

Step -2 Aggregating and averaging across dimensions within each gender group using geometric mean

For women and girls, the formula is -

The rescaling by 0.1 of the maternal mortality ratio in the aggregation formula for

$$G_F = \sqrt[3]{\left(\left(\frac{1}{MMR}\cdot\frac{1}{AFR}\right)\right)^{1/2}\cdot(PR_F\,.SE_F)^{1/2}\cdot LFPR_F}$$

Where, MMR =Maternal Mortality Rate , AFR = Adolescence Fertility Rate, PR_F =Share of women's representation in state assembly, SE_F = Attendance percentage of total enrolment of females in higher classes and $LFPR_F$ = Female participation rate in the labour market.

And for men and boys the formula is-

$$G_M = \sqrt[3]{1\cdot(PR_M\cdot SE_M)^{1/2}\cdot LFPR_M}$$

H_M =1 , assuming the access to HCF by males is 100 percent (as our concern is to assess the deprivation of the females supposing the level of access to HCF by males as the norm) .In other words ,as males do not require any reproductive health care at all, deprivation of the males is zero percent or access is 100 percent

Where , PR_M = Percentage of male representation in Legislative Assembly

SE_M = Percentage of attendance in higher classes by male students

$LFPR_M$ = Participation rate of males in the labour market

women and girls is needed to account for the truncation of the maternal mortality ratio minimum at 10 . This is a new adjustment introduced in UN Human Development Report 2011.

Step-3 Aggregating and averaging across gender groups using a harmonic mean .

Aggregating and averaging across gender groups using a harmonic mean can be represented as follows-

$$HARM(G_F, G_M) = \left[\frac{(G_F)^{-1} + (G_M)^{-1}}{2}\right]^{-1}$$

Using the harmonic mean of geometric means within groups captures the inequality between women and men and adjusts for association between dimensions .

Step-4 Calculating the Geometric mean of the arithmetic means for each indicator

The reference Standard for computing inequality is obtained by aggregating female and male indices using equal weights (thus creating the genders equally) and then aggregating and averaging the indices across dimensions .

$$G_{F,M} = \sqrt[3]{\overline{Health} \cdot \overline{Empowerment} \cdot \overline{LFPR}}$$

Where *Mean Health* Index,

$$\overline{Health} = \left(\sqrt{\frac{1}{MMR} \cdot \frac{1}{AFR} + 1}\right)/2$$

Mean Empowerment Index ,

$$\overline{Empowerment} = \left(\sqrt{PR_F \cdot SE_F} + \sqrt{PR_M \cdot SE_M}\right)/2$$

Mean LFPR,

$$\overline{LFPR} = \frac{LFPR_F + LFPR_M}{2}$$

Mean health index should not be interpreted as an average of corresponding female and male indices but as half the distance from the norms established for the reproductive health indicators –fewer maternal mortality and fewer adolescent pregnancies .

Step-5 Calculating the Composite Gender Inequality Index (GII)

Comparing the equally distributed gender index to the reference standard yields the GII as follows :

$$\text{Composite GII} = 1 - \frac{Harm(G_F, G_M)}{G_{\bar{F},\bar{M}}}$$

The Gender Inequality Index (GII) reflects women's disadvantage in three dimensions- reproductive health, empowerment and labour market. As indicated earlier, the index shows the loss in human development due to inequality between female and male achievements in theses dimensions. It ranges from 0 which indicates that women and men fare equally, to 1, which indicates that women fare as poorly as possible in all measured dimensions.

IV Data Base of the Study :

The data base of our study have been official reports, journals and books which are mainly of secondary types. For the calculation Gender Inequality Index(GII), we have followed the procedure as presented in the Statistical Annex of Human Development Report-2010 and 2011. While National Family Health Survey(NFHS-5)-2019-20, Ministry of Health and Family Welfare, Govt. of India provides us the information regarding attainment at secondary and higher education levels and Adolescent Fertility Rate(AFR) for major states of India, Annual report of the Department of Health and Family Welfare-2021-22, Govt. of India gives us the state wise Maternal Mortality Rate(MMR) of India. Report of the Election Commission of India acts as major source of the state level relevant information regarding share of Assembly seats held by each sex for our empirical study. Periodic Labour Force Survey(PLFS)-2019-20, NSSO, Govt. of India provides us the Labour Force Participation Rate(LFPR) in percent according to current weekly status for different states .

V Results and Interpretation :

This section focuses on the results and their interpretation as revealed in our study. But, before that, the following point should be noted.

Though , apart from reproductive health care facilities , percentage of untreated morbidity , immunization and reporting of morbidity itself of females compared to that of

males are factors determining the extent of gender inequality in the access to HCF. For simplicity and convenience ,we have restricted this study to reproductive health care only as far as our concern is for assessing Gender Inequality Index(GII). For reproductive health care the crucial parameters have been supposed to be Maternal Mortality Rate (MMR) and Adolescence Fertility Rate (AFR) which implies during a given time period, the number of maternal deaths per 100,000 live births and number of child births out of total births to women in the age group 14-19 years respectively.

Table-1 presents the MMR and AFR for the year 2019-20. It is observed from the table that AFR for West Bengal , Assam, Bihar, Andhra Pradesh, Jharkhand are quite high (81, 61, 77, 67 and 64 respectively) reflecting low female freedom in decision making in timing of marriage /family planning in these states contributing to greater gender inequality in provisioning of HCF and health awareness in these states. The AFR for Jammu and Kashmir and Kerala is significantly low (9 and 19 respectively) suggesting relatively much less gender inequality in provisioning of health care in one dimension at least . For Chhattisgarh , Himachal Pradesh, Punjab and Uttar Pradesh , the values of AFR lie in the range 20 -24 implying that the situation in these states in respect of scope for females in respect of maternal decision making compared to that of Bihar and WB is relatively better.

The other gender inequality indicator in HCF is Maternal Mortality Rate(MMR) . The states like Assam ,UP , Bihar , Orissa , Rajasthan, Arunachal Pradesh, Chhatisgarh, Madhya Pradesh exhibit very high MMR (205,167,130,136,1471,349,160 and 163 per one lakh of live births respectively) suggesting poor HCF for would- be mothers and it indicates severity in gender inequality in health care facility . The states like Tamil Nadu , Maharastra , Telengana and Andhra Pradesh perform relatively better in respect of M.M.R (58, 38,56 and 58 respectively)suggesting less contribution to gender inequality in respect of HCF . MMR (30)is very low for Kerala implying an excellent HCF for mothers expecting child births .So, as far as gender equality in respect of HCF is concerned, such a low value of MMR (for Kerala) helps Kerala a lot to achieve the lowest gender inequality performer in respect of access to HCF .

Table-1 : Maternal Mortality Rate(MMR) and Adolescence Fertility Rate(AFR), 2019-20

State	MMR	AFR
Assam	205	61
Arunachal Prad	349	38
Andhra Pradesh	58	67
Bihar	130	77
Chhatis garh	160	24
Gujarat	70	34
Haryana	96	27
Himachal Pradesh	63	22
Jammu and Kashmir	91	9
Jharkhand	61	64
Karnataka	83	40
Kerala	30	18
Madhya Pradesh	163	37
Maharastra	38	47
Odisha	136	40
Punjab	114	21
Rajanthan	141	31
Tamilnadu	58	34
Telengana	56	48
Uttrakhand	101	19
Uttar Pradesh	167	22
West Bengal	109	81

Source: Author's own calculation based on the methodology.

Note : MMR-**, the number of maternal deaths per 100,000 live births**

AFR- number of child births out of total births to women in the age group 14-19 years.

Table-2 reveals the Health Inequality Index(H_F) for females . Health inequality index for Female, H_F comes as high as .568 for Kerala indicating lowest gender inequality in access to healthcare . Degree of closeness to value 1 of Female Health Index will indicate more female access to HCF suggesting less gender inequality in health care provisioning. Compared to the value of male health care access index(H_M =1) , the female health care access index, H_F for Tamil Nadu (.535) , Maharastra (.537) , Punjab(.532), Telengana(.530), Himachal Pradesh(.542), Jammu and Kashmir(.555), Haryana(.531) and Uttrakhand (.536) reflect moderate gender inequality in access to HCF . Results obtained for the states like Assam , Bihar ,Odisha and Rajasthan reflect high gender inequality in these states .

Table-2 : Health Inequality Index(H_F)

State	(Health Inequality Index(H_F
Assam	0.514
Arunachal Prad	0.513
Andhra Prad	0.525
Bihar	0.515
Chhatis garh	0.525
Gujrat	0.532
Haryana	0.531
Himachal Prad	0.542
Jand K	0.555
Jharkhand	0.525
Karnataka	0.527
Kerala	0.568
Madhya Prad	0.52
Maharastra	0.537
Odisha	0.521
Punjab	0.532

Rajanthan	0.523
Tamilnadu	0.535
Telengna	0.53
Uttrakhand	0.536
Uttar Prad	0.526
West Bengal	0.516

Source: Author's own calculation based on the methodology.

Table-3 presents the empowerment Index. As far as woman empowerment, in its core form, is concerned two constituents are considered (1) Female representation in democratically elected bodies like State Legislative Assemblies and/or (2) Female attendance level in higher classes in schools . We could gather current information related to female representation in various State Assemblies (Female MLA s) from Election Commission's Website . Surprisingly , female representation in Kerala assembly is awfully low and is as low as 8, scoring low in respect of one of the constituent indicators of female empowerment not matching at all with Kerala's gender equality score in respect of access to health care for females. The Women empowerment index is more or less good for Haryana(26), Chhatisgarh(23) and Andhra Pradesh(22) suggesting the better female representation in the respective state assemblies. The Women empowerment index for Assam is as low as 9 and it indicates very poor female representation in the state assembly.

Table-3: Empowerment Index

	Empowerment Index	
State	Female	Male
Assam	9	44
Arunachal Pradesh	14	67
Andhra Pradesh	22	57
Bihar	18	61
Chhatisgarh	23	59
Gujrat	11	51
Haryana	26	72
Himachal Pradesh	19	81

Jammu and Kashmir	10	81
Jharkhand	19	64
Karnataka	14	73
Kerala	19	84
Madhya Pradesh	16	60
Maharastra	18	75
Odisha	13	60
Punjab	16	74
Rajanthan	19	67
Tamilnadu	19	73
Telengana	19	87
Uttrakhand	18	74
Uttar Pradesh	19	65
West Bengal	21	54

Source: Author's own calculation based on the methodology.

Table-4 highlights the results obtained through five sequential steps in respect of overall Gender Inequality Index(GII) as elaborated in the discussion of Methodology. Kerala has scored the overall lowest GII (.353) and has become the best performer. As regards empowerment, though female educational attendance (SE_F) is very good and even higher than that of all the other states, Percentage representation of Females in Legislative Assembly (PR_F) for kerala is quite low . So , the composite empowerment index for Kerala (19), is exceeded by Assam (9), Andhra Pradesh (14), Punjab(16), Gujarat(11) and Odisha(13). It is noteworthy that in both of the states Kerala and Punjab the female attendance rate in higher classes of school is higher than that of Males . No doubt , in the access to HCF, Kerala performs so well , inspite of the fact that Kerala ranks not so high in empowerment and labor market participation , the overall GII (as obtained by our method) for Kerala is the lowest one .

As regards the overall GII next to Kerala ,the second lowest GII has been scored by Haryana(.355). It has been possible as Haryana's relative performance in respect of all the three parameters has been relatively balanced . Himachal Pradesh has third lowest GII (.396) in respect of overall gender equality among all the states.

Table-4 Composite Gender Inequality Index (GII)

State	Gender Inequality Index ((GII	Rank
Bihar	0.660	1
Arunachal Prad	0.633	2
Asam	0.621	3
Odisha	0.586	4
Madhya Prad	0.573	5
Rajanthan	0.560	6
Jharkhand	0.556	7
Karnataka	0.556	8
West Bengal	0.547	9
Punjab	0.527	10
Uttrakhand	0.521	11
Telengna	0.510	12
Chhatis garh	0.501	13
Maharastra	0.486	14
Andhra Prad	0.481	15
Tamilnadu	0.462	16
Uttar Prad	0.404	17
Gujrat	0.400	18
Jand K	0.399	19
.Himachal Prad	0.396	20
Haryana	0.355	21
Kerala	0.353	22

Source: Author's own calculation based on the methodology.

V Conclusion

In this paper, we have made an attempt to look into the issue of gender inequality, particularly the pattern and nature of interstate variation in respect of health care provision and empowerment in India in 2019-20. In order to do this, we have used a composite Gender Inequality Index(GII) compatible with multidimensional association sensitivity. To assess the degree of gender inequality in health care provisioning, the parameters like Maternal Mortality Rate(MMR) and Adolescence Fertility Rate(AFR) have been used . As far as empowerment is concerned, the dimensions considered here are the share of Parliamentary Representation(PR) held by each sex, attainment at Secondary and Higher Education(SHE) levels and Labour Force Participation Rate (LFPR).

We observed substantial variation among states in respect of gender inequality in the provisioning of health care and implementing empowerment to the people. Kerala has been found to be the best performer among the states of India to administer a kind of health care facility and empowerment where gender inequality has been least. The other states where the gender inequality are remarkably low are Punjab, Tamil Nadu, Sikkim, Maharashtra and West Bengal.

As our study is based on the methodology incorporating inter dimensional interaction leading to multidimensional association sensitivity, the Inequality Indices, so computed in this paper , may encourage policymakers to determine the proper dimension that should receive the marginal assistance.

In our study, we assume that the degree of substitution between any two dimensions is the same. It would be more realistic if the indices can be computed treating some dimensions as more stronger substitute than others, or treating some dimensions as substitutes and the rest as complements. Again, when we talk about gender inequality in health care facility here, we have restricted this study to reproductive health care only .Of course , relative incidence of morbidity to females in general and of untreated morbidity in particular are also indicators of gender inequality in HCF (as already mentioned) . We like to incorporate these in our subsequent studies .

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Impact of Nonfarm Activity on Rural Income Inequality in Nadia District of West Bengal

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Abstract

The study was undertaken to analyse the extent, diversity, inequality and determinants of income of rural households in Nadia district.

The impact of non-farm activity on rural income inequality in the Nadia district of West Bengal has been studied. The non-agricultural activities play a key role in shoring up income and employment opportunities for the rural work force in this district. The average annual income of nonfarmfamilies (Rs.148500) is almost double to that of farm families (Rs.58092). The results of Gini coefficient decomposition have indicated that non-farm income is the largest component (47.05%) of total income, followed by farm income (49.41%). The non-farm income contributes largest to the overall inequality (58.37%) in which non-farm self-employment activity increases the total income inequality, while non-farm wage employment decreases it. The analysis of factors influencing participation of households in different income generating activity showed that human capital endowed with formal and informal education are engaged more in nonfarm activities. The study has suggested development of both farm and non-farm sectors simultaneously to reduce rural income inequality.

Keywords: income inequality, nonfarm activity, Gini-coefficient, rural income, probit model, capital

Introduction:

Non-farm activities refer to economic activities that are not directly related to agriculture, such as manufacturing, services, trade, and migration-driven jobs. These activities play a significant role in shaping income distribution and inequality in rural areas.

It is quite interesting to note that there has been 40-50 per cent increase in rural workforce participation in nonfarm activities. For the past some years, the marginal and small farmers have been feeling the necessity of non-farm income as their meagre land was not sufficient for generating income adequate to maintain the family (Rajshekhar, 1995; Pandey and Singh, 2013). Further, the agricultural sector has been unable to absorb the

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growing rural work force due to falling output elasticities of employment within the sector (Singh et al., 2003). The smallholders and landless households depend on rural nonfarm activities to secure livelihood during the slack agricultural season (Bhakar et al., 2007).It is also observed that educated youths take more interest in engaging themselves in nonfarm activities vis-a-vis their uneducated counterparts.

The nonfarm activities not only significantly increased total household income but also functioned as a safety net through diversifying income sources. Interestingly, large farmers' repeated investments on nonfarm sectors spurred into further employment generation in this sector (Bhakar et al., 2007). Therefore, the synergy of farm and nonfarm activities in the rural areas actually helped people to absorb themselves in employment-generating activities in villages only. Hence, a positive attitude for agriculture and rural development can be envisioned with suitable policies and institutional reforms.

It has been found that repeated non-performance of farm activities for marginal farmers induce them to participate in nonfarm activities and interestingly enough that they earn higher income compared to those with better resource endowment.Many marginal or landless farm families are less capable of mitigating negative shocks, and are more risk averse. In order to have additional income as well as to diversify and undertake activities with returns that may have a low or negative correlation with those of farming, poor households may have stronger incentives to participate in nonfarm activity only.

The employment pattern in the rural areas (unskilled labourers) of West Bengal shows the scarcity of labour during the peak planting (July August) and harvesting (December- January) periods of kharif rice, which is the major crop of the region. During rabi and summer seasons, the less remunerative farm activities seldom fulfil the households' requirements of securing livelihoods and the surplus labour force depends on non-agricultural livelihood options.

The impact of non-farm activities on rural income inequality in Nadia district of West Bengal can be analyzed through several socio-economic and geographical factors.

Seasonal migration is a common livelihood strategy in rural Nadia, where rural workers migrate to urban centers to engage in non-farm employment. Besides, non-migrant households remain reliant on local. This household members are engaged in several nonfarm wage-earning activities (MGNREGS work, construction work, porter, factory worker, shop attendant, house maid, security guard, etc.) and self-employment activities (shopkeeper, electrician, mechanic, cable operator, own business, private tuition, driving own vehicle for carrying goods and passengers, hawker, vegetable and fruit vending, etc.). This study has attempted to answer the underlying question whether nonfarm activity influences the overall household income inequality in rural areas with special reference to farming household of Nadia district.

Data and Methodology:

As of the most recent data, the cultivable land area in Nadia district of West Bengal covers approximately 3,924 square kilometers. Nadia is primarily an agricultural district, with rice, jute, and vegetables being the predominant crops. It is known for its diverse agricultural output, which also includes potatoes, mustard, and pulses during different growing seasons.

Nadia district primarily has alluvial soil, which tends to have a pH range between 6.5 and 7.5, depending on specific locations and agricultural practices.

The cropping intensity in 1990-91 in Nadia District was 230.34% that rose to 243.07% in 2000-01 and 249% in 2010-11. The cropping intensity tends to be quite high due to multiple cropping practices (growing more than one crop on the same land during the year). Farmers often cultivate two to three crops in a year due to favorable agro-climatic conditions.

In this study, primary data were collected through a household level survey in six randomly selected villages, namely Haranagar, Arpara, Bilkumari, Chichuria, Khanthalberia, Uttarbahirgachi of Nakashipara community development (CD) block under Krishnanagar Sadar Subdivision for the agricultural year 2022-23. From each village, 30 households were selected randomly that ultimately rounded to total 180 rural households who were personally interviewed adopting a pretested structured schedule

It's expressed as a percentage and calculated by dividing the total cropped area by the net sown area and multiplying by 100.

Analytical Tools:

To study the impact of non-farm income on rural inequality, the non-farm income was considered as an exogenous transfer. We decomposed the total household income and studied the distribution of each income source and its contribution to total income inequality

(i) Decomposition of Gini Index :

The Gini index of total income, Gt , can be decomposed as:

$$G_t \sum_{k=1}^{k} R_k G_k S_k \ldots (1)$$ (Pyatt et al. (1980) andStark et al. (1986))

where, S_k is the share of income component k in total income, G_k is the Gini coefficientof income component k, and R_k is the Gini correlation of income component k with total income defined as:

$$G_k = \frac{cov[Y_k, F(Y)]}{COV[Y_k, F(Y_k)]} \ldots\ldots\ldots\ldots (2)$$

Using Gini decomposition technique, the extent of contribution to the overall income inequality, as influenced by a particular income source, the relative concentration coefficient of income component k can be determined by formula (3)

$$g_k = \frac{G_k R_k}{Go} \ldots\ldots\ldots\ldots (3)$$

where, gk is the relative concentration coefficient of income component k in the overall inequality. The income component k worsens the overall income inequality if gk >1 and has an equalizing effect if gk < 1. The Gini decomposition technique explores the contribution of an income component inincreasing or decreasing the overall income inequality. The most contributory factor to the total can be understood by the regression-based approach to inequality decomposition which quantifies the relative contribution of various income determinants to the inequality in a given income component (Adams, 2001).

Results and Discussion:

The respondents were marginal, small and semi-medium farmers based on the size of operational holdings. The number of respondents under different categories, presented in Table 1, showed that the majority of sample farmers belonged to the marginal group with operational holding-size of less than or equal to 1.25 acres (43.89%), followed by small farmers (40.56%) and semi-medium farmers (15.55%). The marginal and small farmers were predominantly mono-cropped with cropping intensity of 119 per cent (Rahaman and Haldar, 2014). This signifies the fact that the household members, not engaged in round-the-year farming activity, functioned as a pull factor for involvement in nonfarm activities.

Table 1. Categorization of sample farmers based on landholding-size

Different types of farmers	Number of farmers	Size of holdings (land in acres)	
		Ownership holding	Operational holding
Marginal farmers	68 (37.78)	0.57	0.91
Small farmers	63 (35)	1.39	1.71
Semi-medium farmers	49 (27.22)	3.02	3.56
Total	180	1.32	1.68

Note: Figures within the parentheses indicate per cent to the total.

Table 1, showed that the majority of sample farmers belonged to the marginal group with operational holding-size of less than or equal to 1.25 acres (37.78%), followed by small farmers (35%) and semi-medium farmers (27.22%).This signifies the fact that the household members, not engaged in round-the-year farming activity, they involved in nonfarm activities also.

The income of rural household was from farm, nonfarm sources. The farm sector included agriculture, livestock, fishing. Formal or informal wage-employment and self employment were the two major sources of non-farm income. Table 2 presents some key indicators about sample respondents.

scription of sample statistics, 2022-23

Particulars	All Households	Households that do not participate innonfarm activity	Households thatparticipate in nonfarm activity
Household income			
Farm income	37135 (34158)	33965 (19784)	38334 (38250)

Nonfarm income	41510 (55109)	-	57203 (57364)
Other income	15592 (33912)	22116 (43215)	13125 (29598)
Total income	94237 (78906)	56081 (39321)	108662 (85256)
Characteristics of households			
Males	1))2	1))1	1))2
Females	1))2	1))1	1))1
Number of dependents	2))2	1))1	2))2
Average No. of working population	2))3	1))3	2))4
Average number of schooling years of household-head	10.21 (6.14)	4.94 (4.19)	6.18 (4.07)
No. of members that have received some technical training	1 (1)	1 (1)	1 (1)
Distance from village centre to the nearest railway station (km)	16.13 (7.93)	16.61 (7.91)	15.95 (7.99)
Distance from village centre to the nearest bus stop (km)	1.96 (0.55)	2.10 (0.57)	1.91 (0.54)
Average ownership holding-size (acre)	2.35 (1.76)	1.19 (0.85)	1.34 (1.35)
Average net cropped area (acre)	1.68 (1.19)	1.58 (1.06)	1.69 (1.22)
Average leased-in land (acre)	0.49 (0.82)	0.39 (1.15)	0.51 (0.75)
Average leased-out land (acre)	0.15 (0.73)	0.03 (0.09)	0.17 (0.79)
Average gross cropped area (acre)	3.2 (2.11)	1.73 (1.04)	2.04 (1.80)
Number of observations	180	27	153

Note: Figures within the parentheses indicate standard deviation

Table 2 presents some key indicators about sample respondents. Across the total farm households in the sample, 34 per cent had only farm income and 66 per cent had both farm and non-farm income. The average annual income of the households that participated in non-farm activity (Rs.148500) was higher than those households who participated in the farm activity only (Rs.58092). However, agriculture provided employment to a larger number of farm family members, but on an average, non-agricultural activity contributed to the major part of total income of farm households. Table 2 summarizes the characteristics of sample households and indicates the significance of their participation in non-farm activity for income and livelihood. The average number of workers was threeper household, comprising two males and one female member with two dependent members per family. The average years of education of household-head was 10.21, that shows completion of primary level schooling. The average ownership holding per household was 2.35 acres, while the gross-cropped area was 3.2 acres.

Decomposition of Gini Coefficient:

The results of Gini coefficient decompositionpresented in Table 3 by income source for all Household.

Table 3. Inequality decomposition by income source for all rural households

Income sources	Income share (S_k)	Gini's concentration ratio (G_k)	Gini correlation (R_k)	Contribution to Inequality [$S_kG_kR_k/g_{o]}$	Relative concentration Coefficient $\{g_k=G_kR_k/G_o\}$
Total income	100.00	0.30			
Farm income	30.57	0.30	0.79	32.06	0.90
Agriculture	11.25	0.37	0.73	13.70	0.70
Livestock	2.11	0.16	0.83	2.90	0.40
Fishery	15.11	0.69	0.45	5.33	0.80
Agricultural labour	2.10	0.77	0.94	11.13	1.87
Nonfarm income	40.41	0.61	0.84	**59.35**	1.32
Self-employment	26.47	0.66	0.69	47.87	1.45

Non-agricultural labour income	13.94	0.34	0.91	10.39	0.69
Other incomes	29.02	0.31	0.37	7.57	0.38
Salary income	21.52	0.90	0.23	5.16	0.53
Pension, remittances, etc.	6.23	0.83	0.14	1.31	0.35
Land rent	1.27	0.82	0.40	1.21	0.84

the first column shows that non-farm income is the largest component of inequality in the total income (40.41%), followed by farm income (30.57%); and as expected, non-farm income also contributed largest to the overall inequality (59.35%). The Gini coefficient of 0.30 for total income reveals a value that lies within the range seen in many other developing countries. The Gini coefficients for various income components like fishery, agricultural labour, self-employment, salary income, pension & remittance and land rental income were much higher than that of total income because not all households derived income from each of the mentioned sources.

Analysis of Factors Affecting Participation in Different Income Generating Activities

To analyse the probability of participation in various nonfarm activities by the households subject to different factors that influenced the participation in a given activity, the probit regression technique was employed using SHAZAM. The results (Table 4) depict that the households with a higher number of working male and female members were more likely to participate in the non-farm activity.

Table 4. Regression results of participation in non-farm activities (Probit model)

Particulars	Regression 1:Nonfarm activity	Regression 2:Self-employment activity	Regression 3:Wage payingactivity
Net cropped area (acre)	0.361** (0.171)	0.101 (0.10)	0.05 (0.136)

No. of dependents in family	0.258* (0.123)	0.022 (0.054)	0.402*** (0.121)
Age of the house-hold-head	-0.03* (0.014)	-0.01 (0.011)	-0.015* (0.014)
Average number of years of education of household-head	0.111** (0.046)	0.06** (0.026)	-0.025 (0.032)
Number of household members trained	0.602** (0.295)	0.066 (0.383)	-0.18 (0.307)
Distance from nearest railway station	-0.02 (0.025)	-0.027 (0.011)	0.022 (0.023)
No. of working males	0.554*** (0.208)	0.066 (0.132)	0.633*** (0.186)
No. of working fe-males	0.613** (0.277)	-0.138 (0.17)	0.706*** (0.229)
Membership in any self-help group	1.18* (0.69)	0.405 (0.51)	-0.044 (0.537)
Constant	-1.026 (0.975)	-0.212 (0.678)	-1.935** (0.778)
McFadden R-squared	0.211	0.052	0.255
Akaike criterion	123.445	161.645	134.267
Hannan-Quinn	134.414	162.734	145.326
Log-likelihood	-51.723	-70.823	-56.134
Schwarz criterion	150.621	188.840	151.442

Note: Figures within the parentheses indicate standard error. ***, ** and * denote the significance at 1 per cent, 5 per cent and 10 per cent levels, respectively.

Form Table 4, the variable 'average number of years of schooling of household-head' measured the human capital endowment that positively influenced participation in non-farm activity, especially in many self-employment generating activities like village tutor,-various entrepreneurship (electrical and electronics goods sale and repairing) and many more. The education of household-head was considered as a crucial factor because all the decisions of household members were either directly dictated or greatly influenced by him/her. Hence, education provides the motivation of participation in more remunerative non-farm activities to alleviate poverty and avail opportunity to compensate the asset disadvantage (Rahaman et al., 2015). Thus, an educated/skilled person fits easily in a non-farm job, whereas an uneducated/unskilled is left with much choice other than to opt for non-farm wage employment. The number of households who had received some technical training or had membership in any SHG, influencedthe quality of labour force positively in participating in non-farm activities. Further, any sort of training with knowledge of technology and management improved the competence of the household members and facilitated their participation in nonfarm works. In short, human capital endowed with formal or informal education, was engaged more in the non-farm activities. The number of dependents of a family positively influenced the participation in nonfarm wage-earning activities like housemaid, embroidery works, etc. for enhancing livelihood security. The distance from nearest railway station and bus stop was found statically non-significant, indicating a good connectivity of villages with the mega city Kolkata and its sub-urban areas and it encouraged local migration for seeking non-farm employment. The distribution of non-farm income was unequal among the rural households because not all the sample households participated in the non-farm activities. Thus, the opportunity cost of rural labour was very weak locally for participation in the farm and non-farm activities.

Conclusions:

The study has explained that participation in non -farm activities can provide opportunity to the households with low farm productivity to supplement their income. The households endowed with greater human/ technical capital can opt for some skilled wage -earning activities including self-employment. Also, with rising population, declining land-man ratio, degraded soil fertility and dwindling land and labour productivity, agriculture alone would not able to provide adequate income and employment to the rural households. Under such circumstances, to ensure a regular flow of income for a decent living and to achieve food and nutritional security, the household members have to depend more on non-farm income generating activities to supplement the farm income. Thus, rather than raising inequality, the non-farm sector can neutralise or atleast reduce income inequality in the rural areas. The study has observed the contribution of farm sector to average family income as around 40 per cent that can cater to the basic requirement of the family, but a greater portion of household income is being generated through

non-farm sector. Therefore, it will be appropriate to follow an integrated approach for the development of both farm and non-farm sectors by developing appropriate infrastructures and other income-generating facilities in the non-farm sector.

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Gender Discrepancy in Literacy among the Tribal Population in Darjeeling Hills, West Bengal

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Abstract

While literacy is the cornerstone of education as well as a critical means of choosing livelihoods and empowering people, a substantial gender gap in literacy historically persists in India. This gender disparity has been formalised and institutionalised through a matrix of socio-cultural norms and practices prevailing in the society, and this has led to gender discrimination in all spheres of socioeconomic life. Consequently, even in the current era the women are one of the socioeconomically disadvantaged sections of people in Indian society, and their social status is far below than men compared to their male counterpart. The problem is fuelled further when caste dimension of the population is brought into the analysis. While the tribes are the earliest inhabitants of India, the level of both male-female literacy is much lower and gender gap in literacy much higher for the scheduled tribe [STs] population compared to that of non-tribal population. Consequently, the Government of India has provided some special constitutional provisions for the STs treating them as a single entity as done by multiple studies on the issue of tribal literacy. However, the tribal sub-communities are heterogeneous in originality, customs and socio-culture as well as in spatial and regional inhabitance. Since more than one-fifth of population of Darjeeling Hills is STs, the analysis of gender discrepancy of literacy for STs will be more meaningful in this district compared to other districts of the state. Thus, the paper attempts to assess and analyse the gender gap in literacy for the STs across the CD Blocks of Darjeeling District of West Bengal as well as literacy gains and dynamism in this gender gap from 2000-01 to 2010-11[3] *based on secondary census data on literacy for the STs. The paper principally expounds that the male-female literacy was much lower in the plain blocks, where most of the STs belong to Austro-Asiatic and Dravidian language families and are land less tea-labourers, compared to that in the principal agricultural and tea-growing hill blocks where the STs primarily belong to Tibeto-Burman language family and many have interaction with Christian missionaries, and suggests distinct measures for raising their literacy level and reducing gender gap in literacy for the STs in plain and hill blocks.*

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3.The Data is based on the last Census conducted In 2011

Introduction

Education is the cultural process through which each new-born human infant is transformed into a full member of a specific human society (Khanda, 2018). The basis of this education is literacy, and through acquiring basic or primary education people become literate. Literacy of people is an important indicator of cultural and socioeconomic development in any region. Acquiring literacy is a crucial strategy for eradicating poverty, controlling population and for achieving over all development (UNESCO, 2010). It enables individuals to achieve their goals, to develop their knowledge and potential as well as to participate fully in their community and societal life and activities. It is a critical embodied asset that provides individual to access to opportunities and activities, thus to form their livelihoods. Literacy is also an important means to empower women as it assists them to involve in paid economic works and makes them stronger to take decisions in their family affairs (Thingbaijam, 2021). However, in developing countries like India, the literacy rate of population is historically low with significant gender disparity.

In India one of the deep-rooted forms of inequality is gender discrepancy. The gender discrepancy in literacy can be understood in the broader perspective of the position that women occupy in the society (Ghosh, 2007). The Indian women are one of the socioeconomically disadvantaged sections of people in the society. The gender disparity has been formalised and institutionalised through a matrix of socio-cultural norms and practices prevailing in the society, and this has led to gender discrimination in all spheres of socioeconomic life. This has further contributed to inequality of status between men and women. The problem is pronounced further when gender disadvantage is compounded by class, caste and religious discrimination (*ibid.*).

The term, tribe, comes from the word 'tribus' which in Latin is used to identify a group of persons forming a community and claiming descent from a common ancestor. Tribes are the ethnic group of primitive people or earliest inhabitants. A racial grouping known as a tribe is made up of a specific class of people who mostly inhabit forests and highlands under primitive conditions and still not popularly known in more modern culture. For centuries, the tribal groups are marginalized (Chanda, 2005), and have remained outside the realm of the general development process (Planning Commission, 2010), since most of the tribal areas are hilly, inaccessible undulating plateau lands in the forest areas of the country, and thereby are isolated from the mainstream socio-culture and economy . Literacy is also an important indicator of development among ethnic communities, while the gap in literacy between tribal men and women is significant.

The tribal population is an integral part of the social fabric of India and is the second concentration after the African continent (Dey, 2023; Mula & Mundu, 2024). As per Census 2010-11, India accounted for a sizeable tribal population of 10.4 cores constituting

8.61 per cent of the total Indian population, with 705 groups each with their distinct cultures, social practices, religions, dialects, and occupations, and are scattered in all States and Union Territories in India. In the country, the state of West Bengal has the distinction of having 40 tribal groups. According to 2011 census, the scheduled tribe population of West Bengal is 5.29 millions, which constitutes 5.8 per cent of the total population and is unevenly distributed in the districts, while in Darjeeling District 21.5 percent population are STs which constitutes 7.5 per cent of the state STs.

As per Census of India 2010-11, India had achieved only 73.0 per cent literacy with 80.9 per cent for male and 64.6 per cent for female, while for the Scheduled tribes [STs] the literacy rate is just 59.0 per cent with 68.5 percent for males and 49.4 per cent for females. According to the same census, the West Bengal state had accounted for 76.0 per cent overall literacy with 81.7 percent literacy for males and 70.5 per cent for females, while for the schedules tribe population the literacy rate is just 57.9 per cent with 68.2 per cent for the males and 47.7 per cent for the females. Again, Darjeeling District has achieved 79.6 per cent literacy with 85.6 per cent for male and 73.3 per cent for female, while for the Scheduled tribes [STs] the literacy rate is just 74.3 per cent with 81.5.5 per cent for males and 67.5 per cent for females. Thus , in the state and in the nation, the literacy rates for the scheduled tribes is the lowest compared to that of other communities, and the gender gap is literacy is also highest for the scheduled tribes compared to that of other communities. However, the level of economic development and composition of ST population vary substantially across the districts of the state. Since more than one-fifth of population of Darjeeling Hills is STs, the analysis of gender discrepancy of literacy for STs will be more meaningful in this district compared to other districts of the state. While the Lepchas are the aboriginal inhabitants in this region, for the rapid development of tea industry local labour supply was quite inadequate, and thereby huge tea labourers were employed on the tea estates in the hills from Nepali immigrants and in the tarai from Nepal and Chota Nagpur (O' Malley, 1907). Moreover, for understanding the literacy gains for the male and females ST population, it is necessary to analyse the .issue of gender discrepancy in tribal literacy over a period of time

Under this backdrop the paper attempts to assess and analyse the gender gap in literacy for the STs across the CD Blocks of the district of West Bengal as well as literacy gains and dynamism in this gender gap from 2000-01 to 2010-11 based on secondary census data on literacy for the STs, .review of related literature and observation

Objectives of the Study

One of the objectives of the paper is to evaluate and compare the literacy of both males and females as well as gender discrepancy of literacy between STs and Non-STs

across the different CD blocks of the district lbased on Population Census, 2010-11. The principal objective of this paper is to design appropriate block specific measures for improving the overall literacy along with reducing gender gap in literacy for the STs with the ultimate aim at improving the standards of living of all tribal groups of people and empowering tribal women in the Darjeeling Hills of West Bengal.

Urbanisation has significant positive influence on literacy irrespective of the caste of the population. Some of the Darjeeling blocks include urban region. For instance, out of three blocks of Kalimpong Subdivision under Darjeeling District, only Klimpong-1 Blocks has urban tract in the name of Kalimpong Municipality, while other two have no urban tract. Hence, naturally Kalimpong- 1 block must have higher literacy irrespective of any caste people compared to Kalimpong-1 Block or Gorubathan Block under Kalimpong Subdivision. Hence, to compare the literacy of Darjeeling Blocks the paper considers only CD Blocks ignoring urban tract. However, to comprehend the difference in rural and urban literacy for the district, state and the nation their overall literacy and rural literacy are mentioned.

Methodology

The data set used in this paper is detailed household-level secondary data of the ST population from the Primary Census Abstract of the State West Bengal and Darjeeling District for the Population Census 2010-11. For analysis of the data simple percentage technique is applied, and the data is represented through tabular method.

Hypotheses

One hypothesis of this paper is that the gender gap of literacy of the tribals is less compared to that of other people in the district and its CD Blocks. Another hypothesis of this paper is that the tribal literacy of both males and females is much higher and gender discrepancy of tribal literacy is much lower in the hill blocks compared to the plain blocks of the district.

General Description of the Study Region

Darjeeling is the northernmost among the districts in West Bengal, and is also among its smallest districts, with a mountainous area of 2157 sq.km spread over Darjeeling Sadar, Kalimpong and Kurseong subdivisions, and a plains area of 949 sq.km covering Siliguri subdivision (Chakraborty, 1986). The district is situated between 26°31'N & 27°13'N latitude and 87°59'E & 88°53'E longitude (*ibid.*).

Within its compass, the district includes three widely differing physiographic tracts comprising

(a) the mountain region to the west of the Tista which includes the Darjeeling Sadar and Kurseong subdivisions,

(b) the mountain region to the east of Tista which is spanned by Kalimpong subdivision, and

c) the terai which is spanned by Siliguri subdivision (O'Malley, 1907).

The British decision to acquire Darjeeling from Sikkim in 1835 for setting up a health resort, and their subsequent decision to commence the plantation of tea in the region west of the Tista since 1856 played a crucial role in the development of Darjeeling district (*ibid.*). Large areas of forest land were brought under cultivation. The new plantations encouraged a wave of Nepali migration to the west to labour in the new tea plantations, swelling the population of Darjeeling from insignificant to sizeable levels, while also laying the foundations for a more advanced hill economy to which the opening of communications via the Hill Cart Road in 1861 and the Darjeeling Himalayan Railway in 1881 contributed notably *(ibid*.). Forestry development through an organised Forest Department also contributed to economic development (*ibid.*).

The hill regions to the west of Tista, i.e., present Darjeeling Subdivision and Kurseong Subdivision and the terai region, i.e., the present plain subdivision Siliguri were brought under the district territory by the British from Sikim Raja in 1836 and 1850 respectively, while the hill region to the east of Tista, i.e., present Kalimpong Subdivision was added to the district from Bhutan in 1866 (Dash, 1947). The British Administration had developed Kurseong Subdivision separating it from Darjeeling Subdivision in 1891, Siliguri Subdivision by separating it from Kurseong Subdivision .(.in 1891, and Kalimpong Subdivision in 1916 (*ibid*

Results and Discussion

Demographic Profile

As per Census 2010-11, the total STs in the state West Bengal was 5296954, which was 5.8 per cent of the state total population and 5.1 per cent of the nation ST population. However, the STs are not evenly distributed in the districts of the state. Table 1.1 shows the absolute and relative distributions of ST population in West Bengal districts below**.**

Table 1: Spatial Distribution of ST Population in West Bengal in 2010-11

Country/State/District	Total Population	Scheduled Tribe [ST] Population	% of ST Population to Total Population	% of District ST to State ST Population
India	1.21E+09	1.05E+08	*8.6*	–
WEST BENGAL	91276115	5296953	*5.8*	–
Darjeeling Dt	1846823	397389	***21.5***	***7.5***
Jalpaiguri Dt	3872846	731704	***18.9***	***13.8***
Koch Bihar Dt	2819086	18125	*0.6*	0.3
Uttar Dinajpur Dt	3007134	162816	*5.4*	3.1
Dakshiin Dinajpur Dt	1676276	275366	***16.4***	5.2
Maldah Dt	3988845	313984	*7.9*	5.9
Murshidabad Dt	7103807	91035	*1.3*	1.7
Birbhum Dt	3502404	242484	*6.9*	4.6
Barddahaman Dt	7717563	489447	*6.3*	**9.2**
Nadia Dt	5167600	140700	*2.7*	2.7
North Twenty Four Parganas Dt	10009781	264597	*2.6*	5.0
Hugli Dt	5519145	229243	*4.2*	4.3
Bankura Dt	3596674	368690	***10.3***	***7.0***
Puruliya Dt	2930115	540652	***18.5***	***10.2***
Haora Dt	4850029	15094	*0.3*	0.3
Kolkata Dt	4496694	10684	*0.2*	0.2
South Twenty Four Parganas Dt	8161961	96976	*1.2*	1.8
Paschim Midnapur Dt	5913457	880015	***14.9***	***16.6***
Purba Midnapur Dt	5095875	27952	*0.5*	0.5

Source: *Primary Census Abstract, 2010-11*

The dominancy of STs out of the total STs of the state was relatively greater (≥7 per cent) in the districts Paschim Medinapur, Jalpaiguri, Purulia, Barddahaman, Darjeeling and Bankura, and it was highest at 16.6 per cent in Paschim Midnapur District and second highest at 13.8 per cent in Jalpaiguri District, while it was relatively lower at 7.5 per cent in Darjeeling District. However, the relative ST population, i.e., STs out of total population, was comparatively higher (>10 per cent) in the districts Darjeeling, Jalpaiguri, Purulia, Dakshiin Dinajpur, Paschim Midnapur and Bankura, and it was highest at 21.5 per in Darjeeling District, while it was much lower at 14.9 cent and18.9 per cent in Paschim Medinapur and Jalpaiguri Districts respectively. Hence, because of the highest relative dominance of STs in Darjeeling District, any socio-economic study on STs will be more meaningful in the context of Darjeeling Hills as compared to other districts of the state.

The STs are not homogeneous and they are not evenly spread across the districts of the state. Table 2 exhibits subcommunity-wise ST population and the dominant district corresponding to each subcommunity below.

Table 2: Subcommunity-wise ST Population in West Bengal in 2010-11

ST Subcommunity/ State ST Population	Households No.	Total Population	Male Population	Female Population	Dominant District	% of the Total Subcommunity Population	% of State ST Population
Baiga	3,190	13,423	6,765	6,658	W. Midnapur	95.8	0.3
Bedia, Bediya	22,587	88,772	44,989	43,783	N. 24 PRGS	32.6	1.7
Bhumij	86,752	376,296	190,087	186,209	Puruliya	27.8	7.1
Bhutia, Sherpa, Toto, Dukpa, Kagatay, Tibetan, Yolmo	16,278	66,627	33,278	33,349	Darjeeling	74.2	1.3
Chero	2,777	5,477	2,693	2,784	N. 24 PRGS	40.9	0.1
Chik Baraik	5,150	21,376	10,615	10,761	Jalpaiguri	66.7	0.4
Gond	4,908	13,535	7,122	6,413	N. 24 PRGS	37.4	0.3
Ho	5,651	23,483	11,786	11,697	W. Midnapur	62.4	0.4
Kharwar	5,075	20,270	10,439	9,831	Maldah	51.5	0.4
Kisan	23,546	98,434	50,897	47,537	Maldah	94.1	1.9
Kora	35,816	159,404	79,707	79,697	Bardhaman	23.4	3.0
Lepcha	**8,058**	**33,962**	**17,148**	**16,814**	**Darjeeling**	**98.2**	***0.6***
Lodha, Kheria, Kharia	26,868	108,707	54,692	54,015	W. Midnapur	47.6	2.1
Lohara, Lohra	6,942	24,783	12,413	12,370	Jalpaiguri	29.7	0.5
Mahali	19,305	81,594	40,740	40,854	Jalpaiguri	33.0	1.5
Mal Pahariya	11,632	44,538	22,364	22,174	Murshidabad	31.6	0.8
Mech	9,690	41,242	20,851	20,391	Jalpaiguri	91.5	0.8
Munda	91,107	366,386	184,098	182,288	Jalpaiguri	23.5	6.9
Nagesia	8,038	16,378	8,241	8,137	Nadia	29.2	0.3
Oraon	140,875	643,510	322,933	320,577	Jalpaiguri	57.3	12.1
Rabha	12,646	27,820	14,255	13,565	Jalpaiguri	52.1	0.5
Santal	562,526	2,512,331	1,248,370	1,263,961	W. Midnapur	21.3	47.4
Savar	10,028	40,374	20,064	20,310	W. Midnapur	45.0	0.8
Limbu (Subba)	**11,558**	**46,847**	**23,299**	**23,548**	**Darjeeling**	**88.1**	***0.9***
Tamang	**36,029**	**146,203**	**72,594**	**73,609**	**Darjeeling**	**77.5**	***2.8***
WB Total ST (Selected)	1,167,032	5,021,772	2,510,440	2,511,332	–	–	–
WB Total ST	1,241,874	5,296,953	2,649,974	2,646,979	–	–	–

Source: *Census of India, 2010-11*

Out of 40 ST subcommunities of the state West Bengal, the paper considers 25 ST subcommunities as major ST subcommunities in the sense that the population under each of such ST subcommunity is at least 5000. The selected 25 major ST subcommunities of the state jointly comprise 94.8 per cent of total ST population of the state. Again, out of these ST subcommunities the most dominant one is Santal which constitutes 47.4 per cent of the state STs, the second dominant one is Oraon which constitutes 12.1 per cent of the state STs, the third dominant one is Bhumij which comprises 7.1 per cent of the state ST population, and the fourth dominant one is Munda which constitutes 6.9 per cent of the state STs. Out of the selected 25 major ST communities, majority of the population of

12 subcommunities, namely Baiga, Bhutia & Sherpa, Chik Baraik, Ho, Kharwar, Kisan, Lepcha, Mech, Oraon, Rabha, Limbu and Tamang are concentrated in single district. For instances, 98.2 per cent of the Lepchas, 88.1 per cent of the Limbus and 77.5 per cent of the Tamangs are concentrated in Darjeeling Hills (currently Darjeeling District and Kalimpong District.

More than fourth-fifth of the district Scheduled tribe population resides in the rural tract of the district. Out of total STs of 397389 of the district, the Bhutia, Sherpa, Toto, Dukpa, Kagatay, Tibetan, Yolmo jointly are of 12.4 per cent, the Lepchas are of 8.3 per cent, the Limbus are of 10.4 per cent, the Tamangs are of 28.5 per cent, the Mundas are of 4.6 per cent, the Santals are of 4.7 per cent, and the Orans are of 18.2 per cent.

Table 3 compares inter-caste demographic characteristics among the 12 community development [CD] blocks that make up Darjeeling district below. While for the state of West Bengal as a whole, average family sizes for total population in 2011 were lower than the national average of 4.85 for India as a whole, average family sizes in Darjeeling district were slightly larger than that of the state . Following to the same trends in national and state averages, rural families in Darjeeling were slightly higher (4.73) than urban families (4.71) for total population. However, following the same trend in the state and opposite trend of the national averages, rural families in Darjeeling were slightly higher than urban families for scheduled tribe population. Both for the rural and urban tracts, following to the same trends of the nation and state averages, average family sizes for STs in Darjeeling were slightly higher than that of total population primarily because of more presence of join families among the tribal communities compared to that of other communities.

Annual population growth rates in Darjeeling district between 2001-2011 (1.5%) were marginally above the state average (1.4%) because of high in-migration as well as natural population growth. Because of high rural-urban migration following the same trends of the state and the nation, annual population growth rates in rural Darjeeling district were lower compared to that of urban Darjeeling. This is also true for annual growth of scheduled tribe population. Because of the Constitution Order, 2002, the Tamangs,

Table 3: Inter-Block Inter-Caste Demography of Darjeeling District (2001-2011)

CD Block/ District/State/ Country	House-holds (Hhs) (No.) 2011	Population (2010-11)			% of ST Hhs to Tota Hhsl	% of ST Popu - -lation to Total Popu - -lation-	% of SC Popu - -lation to Total Popu - lation	Avg. Family Size (2011)		FMR (Female per 1000 Male) (2011)		Annual Total Population Growth (2001-2011)	
		Total	Male	Female				All	STs	All	STs	All	STs
Principal Agricultural Hill Blocks													
Kalimpong-1	15358	74746	37750	36996	*33.5*	*34.3*	*7.0*	4.87	4.99	980	995	*1.0*	*11.6*
Kalimpong-II	13172	66830	34546	32284	*37.1*	*37.1*	*2.9*	5.07	5.07	935	954	*1.1*	*6.7*
Gorubathan	12662	60663	31054	29609	*23.2*	*23.6*	*6.6*	4.79	4.88	953	973	*1.2*	*14.3*
Principal Tea-Growing Hill Blocks													
Darjeeling-													
Pulbazar	27470	126935	63828	63107	*28.5*	*28.8*	*4.6*	4.62	4.66	989	981	*1.0*	*30.7*
Rangli-Rangliot	15304	70125	35025	35100	*33.1*	*33.1*	*5.6*	4.58	4.58	1002	1013	*0.9*	*36.1*
Jorebungalow-													
Sukhiapokri	25468	113516	56232	57284	*30.5*	*30.0*	*5.7*	4.46	4.39	1019	1042	*1.3*	*39.1*
Mirik	9962	46374	23394	22980	*31.2*	*30.8*	*7.8*	4.66	4.59	982	986	*1.0*	*35.5*
Kurseong	20892	94347	47030	47317	*31.3*	*31.0*	*8.8*	4.52	4.46	1006	1001	*1.0*	*28.5*
Plain Blocks													
Matigara	42666	197278	101023	96255	*13.0*	*13.4*	*35.8*	4.62	4.77	953	1046	*5.3*	*4.4*
Naxalbari	35752	165523	85054	80469	*19.0*	*19.6*	*26.8*	4.63	4.76	946	1026	*1.4*	*2.0*
Kharibari	23352	109251	55671	53580	*18.6*	*19.5*	*53.6*	4.68	4.89	962	1003	*2.4*	*2.4*
Phansidewa	42138	204522	103719	100803	*30.3*	*30.6*	*29.7*	4.85	4.90	972	1036	*1.9*	*1.7*
Darjeeling Dt (R)	**236694**	**1118860**	**566965**	**551895**	***28.3***	***28.5***	***20.1***	**4.73**	**4.76**	**973**	**1008**	***0.3***	***7.8***
Darjeeling Dt	**391234**	**1846823**	**937259**	**909564**	***21.2***	***21.5***	***17.2***	**4.72**	**4.79**	**970**	**1015**	***1.5***	***9.5***
West Bengal (R)	13**813165**	**62183113**	**31844945**	**30338168**	***7.7***	***7.8***	***27.5***	**4.50**	**4.56**	**953**	**1000**	***0.8***	***1.7***
West Bengal	20**380315**	**91276115**	**46809027**	**44467088**	***5.7***	***5.8***	***23.5***	**4.48**	**4.57**	**950**	**999**	***1.4***	***2.0***
India (R)	168**612897**	**833748852**	**427781058**	**405967794**	***11.4***	***11.3***	***18.5***	**4.94**	**4.87**	**949**	**991**	***1.2***	***2.2***
India	249**501663**	**1210854977**	**623270258**	**587584719**	***8.6***	***8.6***	***16.6***	**4.85**	**4.86**	**943**	**990**	***1.8***	***2.4***

Source: *Darjeeling District Primary Census Abstract, 2001 & 2011*

Lopchans, Pakhrins, Waibsa, Yonzons, Lamas, Kaldens, Ghisings, Golays, Bumjums, Bloms, Moktans, Zimbas, Sitlings, Las, Syangdens, Subbas, Limboos and Nimbangs became STs, and thus the annual population growth for the STs were well above the annual population growth for total population in the district and its all hill blocks.

For the individual blocks, annual growth of total population was sharpest in the plains blocks (between 1.4-5.3%), lower in the principal agricultural hill blocks (between 1.0-1.2%) and lowest in the hill tea-growing blocks because of local outmigration. With lower population growth in the tea region, families were generally smaller (<4.66) in

the principal tea-growing blocks, including relatively more urbanised Matigara and Naxalbari blocks, than in the agricultural blocks of the hills and plains (>4.68), and were largest at 5.07 in Kalimpong-2 block. The average family sizes for the STs were also relatively higher in the principal agricultural hill blocks compared to that of either principal tea-growing hill blocks or plain blocks, and they were the lower for the principal tea-growing hill blocks. With relatively higher population growth, the average family sizes for the STs were also relatively higher compared to that of other communities in the principal agricultural hill blocks as well as in the plain blocks of the district as well as in the district and in the state, while the opposite happens for the principal tea-growing hill blocks of the district as well as in the nation in conformity to the study (Gang *et al,* 2003). Such variations in family size between different CD blocks directly affect labour force distribution and consumption levels in the district. The larger average family sizes in the agricultural blocks would be directly influenced by higher per capita relative availability of land for cultivation.

The proportions Scheduled Tribes (ST) and Scheduled Caste [SC] population in West Bengal population were 5.8 and 23.5 compared to 8.6 and 16.6 for all-India respectively in 2011. The percentage of ST population as well as the combined percentage of ST and SC population to total population were relatively higher in the district than in the state and nation, while that of SC population was relatively lower in the district than in the state, but was higher in the district than the nation. The percentages of ST and SC population would reside in rural tract were 80.3 and 70.9 in the district compared to 90.0 and 76.4 in the nation and 91.7 and 79.6 in the state. Consequently, the percentage of ST population as well as the percentage of SC population separately to total population was relatively higher in the rural part of district than that of the urban part of the district in conformity to the state and nation. Hence, the improvement of living standard of ST and SC population primarily depends on pace and progress of rural development.

The percentages of SC and combined SC and ST population to total population were comparatively higher in the plain blocks than the hill blocks. The percentages of ST or combined SC and ST population to total population were relatively higher in most hill agricultural blocks than in most hill tea blocks, since in the hill blocks the ethnic ST population primarily depended on agriculture for their livelihood as in case of ethnic SC in the plain bocks where the ST were mainly tea labourers.

Historically, because of higher outmigration of males, the inverse sex-ratio or number of females per 1000 males (i.e. FMR) has been higher in Darjeeling district than in West Bengal or India. While in conformity with the state and the nation, average FMRs in the Darjeeling rural blocks were better than in the urbanised blocks, FMRs in the hill tea blocks were higher than in the agricultural blocks, and were lowest on the whole in the plains blocks. Outmigration of males in the workforce was an important factor influ-

encing high FMRs in the hill region, where there were less work opportunities for males entrants in the workforce. This was true particularly in the tea region, where work opportunities in the tea estates were limited and were hardly available outside the tea sector. Because of absence of son-child preference over girl-child in the tribal societies along with outmigration of males, females per 1000 males (i.e. FMR) has been higher for the STs than that for the Non-STs in most of the district blocks and in the district in conformity to the state and the nation, even female surplus population among the STs in the district and its many blocks, especially in its plain blocks.

Table 4 compares inter-caste male-female literacy for Darjeeling blocks in 2010-11 below.

Table 4: Inter-Caste Male-Female Literacy of Darjeeling Blocks in 2011

	Literacy															
	All Caste Population				Scheduled Tribes [STs]				Scheduled Castes [SCs]				Gap between All Caste Population and STs			
CD Block/ District/State/ Country	Total	Male	Female	Male-Female Gap	Total	Male	Female	Male-Female Gap	Total	Male	Female	Male-Female Gap	Total	Male	Female	Male-Female Gap
Principal Agricultural Hill Blocks																
Kalimpong-1	81.4	86.6	76.2	10.3	81.3	86.5	76.2	10.3	80.7	87.0	74.6	12.5	0.1	0.1	0.0	0.0
Kalimpong-II	79.7	85.6	73.4	12.2	78.7	84.5	72.6	11.9	76.5	84.0	69.3	14.7	1.0	1.1	0.8	0.3
Gorubathan	76.9	84.2	69.2	15.0	74.4	81.8	66.8	15.0	75.9	84.8	67.1	17.8	2.5	2.4	2.4	0.0
Principal Tea-Growing Hill Blocks																
Darjeeling-Pulbazar	80.8	87.6	73.9	13.7	79.9	86.8	72.9	13.9	76.4	84.0	69.0	15.0	0.9	0.8	1.0	-0.2
Rangli-Rangliot	80.5	87.7	73.4	14.3	80.5	87.7	73.5	14.2	75.2	84.3	66.1	18.2	0.0	0.0	-0.1	0.1
Jorebungalow-Sukhiapokri	82.5	90.0	75.3	14.7	82.6	89.4	76.2	13.2	79.0	87.9	70.5	17.4	-0.1	0.6	-0.9	1.5
Mirik	80.8	88.4	73.2	15.2	79.2	87.0	71.2	15.8	77.8	86.2	69.9	16.3	1.6	1.4	2.0	-0.6
Kurseong	81.2	88.6	73.8	14.8	77.7	85.8	69.6	16.2	79.1	87.8	70.9	16.9	3.5	2.8	4.2	-1.4
Plain Blocks																
Matigara	74.8	81.7	67.4	14.3	64.4	73.8	55.5	18.3	69.3	77.1	61.2	16.0	10.4	7.9	11.9	-4.0
Naxalbari	75.5	82.7	67.8	14.9	62.0	71.5	52.7	18.8	71.9	80.0	63.3	16.7	13.5	11.2	15.1	-3.9
Kharibari	67.4	76.0	58.4	17.6	52.6	62.8	42.6	20.2	70.3	78.8	61.2	17.6	14.8	13.2	15.8	-2.6
Phansidewa	64.5	72.6	56.1	16.6	58.0	67.3	49.2	18.1	70.2	78.5	61.3	17.2	6.5	5.3	6.9	-1.5
Darjeeling Dt (R)	**74.3**	81.8	66.6	15.2	70.6	78.7	62.6	16.1	70.6	79.0	61.8	17.1	3.7	3.1	4.0	-0.9
Darjeeling Dt	79.6	85.6	73.3	12.3	74.3	81.5	67.2	14.3	72.9	80.6	65.0	15.6	5.3	4.1	6.1	-2.0
West Bengal (R)	**72.1**	78.4	65.5	12.9	56.7	67.2	46.2	21.0	67.5	75.7	58.9	16.8	15.4	11.2	19.3	-8.1
West Bengal	76.3	81.7	70.5	11.2	57.9	68.2	47.7	20.5	69.4	77.2	61.2	16.0	18.4	13.5	22.8	-9.3
India (R)	67.8	77.1	57.9	19.2	56.9	66.8	46.9	19.9	62.8	72.6	52.6	20.0	10.9	10.3	11.0	-0.7
India	73.0	80.9	64.6	16.2	59.0	68.5	49.4	19.2	66.1	75.2	56.5	18.7	14.0	12.4	15.2	-3.0

Source: *Darjeeling District Primary Census Abstract, 2011*

Compared to the plains blocks, literacy has traditionally been much higher in the hills. Thus, irrespective of castes and rural-urban region, the literacy of the district was well above compared to that of the state or the nation. Again, irrespective of castes, urban literacy were much higher compared to the rural literacy in the district in conformity to the state and the nation. Although male literacy for total population too was invariably high in the tea blocks, it was lower in the hill agricultural blocks in relative terms, and it was lower in the plain blocks compared to that of the hill blocks.

While in the district the literacy for the STs was relatively higher compared to that for SCs, it was comparatively lower than that for SCs in rural Darjeeling as well as in both rural and urban regions for the state and the nation. The literacy for the STs was relatively lower compared to that for SCs in all the plain blocks, while the literacy for the STs was relatively higher compared to that for SCs in all the principal agricultural hill blocks with the exception of Gorubathan as well as in all the hill tea-growing blocks of the district with the exception of Kurseong. Obviously, the literacy for the Non-STs and Non- SCs was much higher than that for the SCs or STs in all the district blocks in conformity to the state and the nation irrespective of rural-urban region. The literacy for the STs was relatively higher in the hill blocks compared to that of the plain blocks as well as in the urbanized hill blocks like Kalimpong-1 and Jorebungalow-Sukhirapokri compared to that in the non-urbanised hill blocks like Rangli-Rangliot.

A moderate level of gender disparity in literacy for total population persisted in the blocks with higher disparities in the rural blocks than in more urbanised blocks, in the plain blocks than in the hill blocks, and in the hill tea blocks than in most hill agricultural blocks in relative terms. The gender discrepancy in literacy was relatively lower for the STs compared to that of either SCs or Non-STs and Non-SCs in the principal agricultural and tea-growing hill blocks inconformity to the hypothesis of this paper, while for the plain blocks of the district the gender discrepancy in literacy was relatively lower for the SCs compared to that of either STs or Non-STs and Non-SCs. The male-female literacy for the STs was comparatively higher in the hill blocks compared to that of the plain blocks of the district. The Gender discrepancy in literacy for the STs was relatively lower in most of hill agricultural blocks compared to that of the plain blocks, even compared to that of most hill tea-growing blocks. Among the STs of the district 4.6 per cent are Mundas, 18.2 per cent are Oran and 4.7 per cent are Santals who primarily reside in the plain blocks of the district and principally work as tea laboures and thereby they are mainly landless. On the other hand, out of the district STs 28.5 per cent are Tamangs, 10.4 per cent are Limbus, 8.3 per cent are Lepchas and 12.5 per cent are Bhutias, etc., who primarily reside in the hill blocks of the district. Moreover, the Lepchas are the aboriginal inhabitants of Kalimpong region of the district, and thereby they have possessed agricultural land and are influenced by Christian Missionaries, while the Bhutias ST sub-communities

mainly reside in the urban tracts of the district and accept trade and commerce as their livelihoods. Thus, land possession and type of ST communities accompanying with urbanization has crucially determined the literacy level and gender discrepancy in literacy for the STs in the district blocks.

.Table 5 below compares inter-censal inter-caste male-female for Darjeeling blocks for 2001-2011

Table 5: Inter-Censal Inter-Caste Male-Female Literacy of Darjeeling Blocks (2001-2011)

CD Block/ District/State/ Country	Literacy in 2001								Change in Literacy between 2001-2011							
	All Caste Population				Scheduled Tribes [STs				All Caste Population				Scheduled Tribes [STs]			
	Total	Male	Female	Male-Female Gap	Total	Male	Female	Male-Female Gap	Total	Male	Female	Male-Female Gap	Total	Male	Female	Male-Female Gap
Principal Agricultural Hill Blocks																
Kalimpong-1	74.1	81.5	66.6	14.9	76.2	83.3	69.2	14.1	7.3	5.1	9.6	-4.6	5.1	3.2	7.0	-3.8
Kalimpong-II	69.6	77.3	61.2	16.2	68.2	75.2	60.8	14.4	10.1	8.3	12.2	-4.0	10.5	9.3	11.8	-2.5
Gorubathan	66.9	76.2	57.2	19.0	56.2	65.5	46.6	18.8	10.0	8.0	12.0	-4.0	18.2	16.3	20.2	-3.8
Principal Tea-Growing Hill Blocks																
Darjeeling-Pulbazar	72.9	82.4	63.2	19.2	67.1	76.7	57.2	19.5	7.9	5.2	10.7	-5.5	12.8	10.1	15.7	-5.6
Rangli-Rangliot	72.8	82.1	63.4	18.6	74.0	82.1	65.8	16.2	7.7	5.6	10.0	-4.3	6.5	5.6	7.7	-2.0
Jorebungalow-Sukhiapokri	76.7	86.9	66.8	20.1	77.8	85.7	70.5	15.2	5.8	3.1	8.5	-5.4	4.8	3.7	5.7	-2.0
Mirik	72.0	82.4	61.7	20.7	62.1	73.7	51.0	22.7	8.8	6.0	11.5	-5.5	17.1	13.3	20.2	-6.9
Kurseong	74.4	84.1	64.6	19.5	59.0	68.0	49.9	18.1	6.8	4.5	9.2	-4.7	18.7	17.8	19.7	-1.9
Plain Blocks																
Matigara	64.8	75.0	53.3	21.7	43.5	55.5	31.3	24.3	10.0	6.7	14.1	-7.4	20.9	18.3	24.2	-6.0
Naxalbari	66.9	77.3	55.4	21.9	41.8	54.5	29.0	25.5	8.6	5.4	12.4	-7.0	20.2	17.0	23.7	-6.7
Kharibari	54.9	67.0	41.9	25.1	33.1	45.7	20.4	25.3	12.5	9.0	16.5	-7.5	19.5	17.1	22.2	-5.1
Phansidewa	50.3	62.2	37.7	24.5	42.1	53.0	31.1	21.9	14.2	10.4	18.4	-7.9	15.9	14.3	18.1	-3.8
Darjeeling Dt (R)	**66.0**	**76.1**	**55.4**	**20.7**	**50.9**	**61.4**	**40.4**	**21.0**	**8.3**	**5.7**	**11.2**	**-5.5**	**19.7**	**17.3**	**22.2**	**-4.9**
Darjeeling Dt	**71.8**	**80.1**	**62.9**	**17.1**	**55.5**	**65.1**	**45.8**	**19.2**	**7.8**	**5.5**	**10.4**	**-4.8**	**18.8**	**16.4**	**21.4**	**-4.9**
West Bengal (R)	**63.4**	**73.1**	**53.2**	**20.0**	**42.4**	**56.6**	**27.9**	**28.7**	**8.7**	**5.3**	**12.3**	**-7.1**	**14.3**	**10.6**	**18.3**	**-7.7**
West Bengal	**68.6**	**77.0**	**59.6**	**17.4**	**43.4**	**57.4**	**29.2**	**28.2**	**7.7**	**4.7**	**10.9**	**-6.2**	**14.5**	**10.8**	**18.5**	**-7.7**
India (R)	**58.7**	**70.7**	**46.1**	**24.6**	**45.0**	**57.4**	**32.4**	**24.9**	**9.1**	**6.4**	**11.8**	**-5.4**	**11.9**	**9.4**	**14.5**	**-5.0**
India	**64.8**	**75.3**	**53.7**	**21.6**	**47.1**	**59.2**	**34.8**	**24.4**	**8.2**	**5.6**	**10.9**	**-5.4**	**11.9**	**9.3**	**14.6**	**-5.2**

Source: *Darjeeling District Primary Census Abstract, 2001 & 2011*

Because of relatively more population growth and consequently pressure on cultivated land, the hill agricultural blocks had attempted to catch up the literacy of the hill tea blocks. Nevertheless the gains in gender literacy and the lowered gender literacy disparity

levels between 2001-2011 indicated that this gap was closing. With relatively lower literacy base for the STs, the gain in male-female literacy for the STs were relative higher compared to that of Non-tribals in both the rural and urban segment of the district in conformity to that of the state and the nation as well as in most of the district blocks, especially in the plain blocks. The gain in male-female literacy for the STs was relatively higher in the plain blocks as compared to the hill blocks. The gain in male-female literacy for the total population was relatively greater for the most plain blocks compared to that for the hill blocks, in the hill agricultural blocks compared to that in hill tea-growing blocks.

Irrespective of the rural and urban region with the gains in male-female literacy for both STs and Non-STs, the gender discrepancy in literacy has lessened in the district, state and in the nation as well as in all the district blocks. However, the reduction in gender discrepancy in literacy has happened more for the Non-STs compared to that of the STs in the district, the state and the nation as well as in all the district blocks. The reduction in gender gap in literacy for both the Non-STs was relatively higher in the plain blocks compared to that in the hill blocks as in the case of reduction in gender discrepancy in literacy for the STs as well as in the hill tea blocks compared to that in the hill agricultural blocks. This relativelylower reduction of gender disparity in literacy for the STs compared to that for the Non-STs indicate relatively more critical literacy status of the ST women compared to that of the literacy status of the Non-ST women even in the Hill society.

Conclusion and Policy Issues

While in absolute ST population Darjeeling District ranked 5th among the districts of the state, the intensity of ST population in total population of the district was highest at 21.5 per cent. Another important aspects of STs of the district is that more than three-fourth of Lepchas, Limbus and Tamangs as well as around three-fourth of Bhutias tribal sub-community population of the state reside in the district, while among the STs of the district 4.6 per cent are Mundas, 18.2 per cent are Oran and 4.7 per cent are Santals residing primarily in the plain CD blocks of the district. The STs are not evenly distributed in the CD Blocks of the district. The intensity of STs are above 30 per cent in all the principal agricultural and tea-growing hill blocks of the district with the exception of Darjeeling-Pulbazar, while it is below 20 per cent in all the plain blocks of the district with the exception of Phansidewa. The females are surplus compared to males for the tribal population of the district, while the opposite had happened for the non-tribal population of the district.

Both the male-female literacy for the STs was higher in the district and it was second highest among the districts of the state just following Kolkata, and the gender gap in literacy was much lower (below 15 per cent) for the STs in the district. However, the male-female literacy as well as gender discrepancy in literacy for the STS varied wide-

ly across the CD blocks of the district following a particular pattern. Both male-female literacy for the STs were relatively higher compared to that for the SCs in most of the principal agricultural and tea-growing hill blocks where the STs primarily belong to Tibe-to-Burman Language family, while the opposite had happened in the district plain blocks where most of the STs belong to Austro-Asiatic and Dravidian language families including Mundas, Santals and Orans. Thus, the male-female literacy for the STs was much lower and gender discrepancy in literacy was much higher in the plain blocks than that in the principal agricultural and tea-growing hill blocks of the district. Land possession, type of ST sub-communities and association with Christian missionaries as in the case for the Lepchas accompanying with urbanization has crucially determined the literacy level and gender discrepancy in literacy for the STs in the district blocks.

In conformity to the nation and state, both male-female literacy for STs and Non-STs had improved marginally and gender discrepancy in literacy for STs and Non-STs reduced slightly in all the CD Blocks of the district during 2000-01 to 2010-11. With relatively lower literacy base for the STs in the plain blocks of the district, the gains in male-female literacy and declines in gender gap in literacy were comparatively greater in the plain blocks than that in the principal agricultural and tea-growing hill blocks of the district. However, despite having higher literacy base for the Non-STs compared to STs in the district blocks, the gains in both male-female literacy and declines in gender gap in literacy were relatively higher for the Non-STs than that of the STs in the plain blocks and most of hill blocks of the district.

Since both the male-female literacy were relatively lower and gender gap in literacy were relative higher for the STs compared to that of Non-STs in the district blocks, the concerned authority, particularly the local authority have to undertake special literacy programmes for the STs in the district blocks keeping keen eye for raising the literacy for the STs, especially for the ST females. The local authority also needs to implement the literacy mission of the Government of India for the STs properly. Since most of the STs in the plain blocks of the district are landless, tea-labours, their problems are distinct than from those residing in hill blocks. Hence, instead of unique measure, the concerned authority has to undertake distinct literacy measure and missions, which are favourable and suitable for the plain STs.

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Unveiling the Drivers of Economic Growth: Evidence from Top HDI Countries

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Abstract

Growth in the gross domestic product per capita is still a key measure of economic progress, particularly in highly developed countries. One of the essential elements of the idea of economic phenomena is GDP per capita growth, and it is crucial to identify the causes that cause and impact each country's GDP per capita. By examining important economic data, this study explores the crucial factors affecting GDP per capita. This study covers 41 years, from 1980 to 2020, using secondary data from the World Bank and concentrating on the top 10 nations as determined by the 2023 Human Development Index (HDI). The Hausman Test revealed that a Fixed Effects Model was appropriate after a panel data regression analysis. The empirical results show a significant and positive correlation between GDP per capita and secondary school enrolment, gross capital formation, and labour force participation rate. Increased labour force participation boosts economic growth by increasing productivity and promoting consumption. In a similar vein, since developed economies are investment-intensive, higher gross capital formation—which reflects more investment in tangible assets—amplifies production through the multiplier effect. Additionally, more secondary school students also symbolize better human capital development, which promotes productivity, creativity, and long-term economic success. In contrast, Interestingly, in these developed economies, the relationship between tax income as a proportion of GDP and GDP per capita levels is not statistically significant. This can be explained by the stable and widely distributed tax systems found in modern nations, where tax receipts naturally increase in proportion to economic output and are not unduly dependent on any one industry. In order to ensure sustained GDP per capita development, the study emphasizes the significance of bolstering investment, education, and labour market activity. These observations have important ramifications for decision-makers who want to sustain the long-term economic performance of developed nations.

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Keywords: GDP per capita growth, Developed Economies, Labour Force Participation, Capital Formation, Secondary Education, Panel Data, Fixed Effects Model, HDI.

1. Introduction

GDP (gross domestic product) per capita is a widely used measure of economic performance and living standards. Knowing its causes is essential, especially in the most developed countries in the world, because even small gains are more difficult to make. It is crucial to determine which factors continue to play a major role in long-term economic performance in light of growing global competitiveness, demographic shifts, and technological upheaval. Since many nations with high HDI scores show different rates of GDP per capita growth, this study is relevant because it shows that development by itself does not ensure sustained economic performance. The study aims to identify the factors that contribute to inclusive and sustainable growth in a developed economy by looking at important macroeconomic indicators like capital investment, labor engagement, educational attainment, and taxation. This work's importance stems from its capacity to educate policymakers in both rich and developing nations about the areas of action that are most likely to result in improvements in income and welfare.

2. Literature Review

Economic literature has extensively examined the connection between GDP per capita and macroeconomic variables. Barro (1991) highlighted the contribution of human capital, particularly education, to economic expansion. Human capital was further incorporated into the Solow growth model by Mankiw, Romer, and Weil (1992), who demonstrated that greater educational attainment accelerates long-term growth. In a similar vein, the OECD and IMF have continuously emphasized the significance of labor market participation as a key factor influencing GDP. De Long and Summers (1991) are among the numerous cross-country and panel data studies that have shown the positive effect of gross capital creation on production.

On the other hand, there is significant disagreement over how tax money contributes to economic expansion. According to certain research, depending on their design and execution, tax laws can have both disincentive and incentive impacts (Tanzi and Zee, 1997). Certain progressive tax schemes may lead to inefficiencies and distortions, but others may lessen income inequality and finance worthwhile public investments. Furthermore, high tax receipts in highly developed economies are frequently used to fund welfare and social security rather than productive capital, which has conflicting effects on growth. According to the literature, the context affects the tax-growth relationship's intensity and direction.

Even with the extensive body of research, only a small number of studies concentrate solely on high-HDI nations, which can have essentially different growth characteristics than emerging economies. By utilizing panel data to separate the impact of particular variables on per capita income in the most developed countries in the world, this study seeks to close that gap.

3. Objectives of the Study

The study is guided by the following specific objectives:

1. to evaluate empirically how tax income, capital formation, education, and labor force participation affect GDP per capita in high-HDI nations.
2. to determine which of these macroeconomic factors influences GDP per capita in a way that is statistically significant.
3. to assess how well fiscal policy—in particular, tax revenue—influences per capita income.
4. To offer guidance to decision-makers who want to maintain economic growth in wealthy nations
5. To make empirically supported recommendations for strategic policy changes that other nations looking for high-income growth models can adopt.

4. Data and Methodology

The study uses panel data econometrics and a quantitative research design. 10 nations—Iceland, Switzerland, Norway, Denmark, Germany, Sweden, Australia, the Netherlands, Belgium, and Ireland—that were continuously placed in the top 10 by HDI between 1980 and 2020 were the subjects of the data collection. These nations retain high levels of development while representing a variety of tax and economic regimes.

There are 410 observations overall, spanning 41 years. The World Bank and IMF databases were the main sources of the data. The following are the main variables:

DEPENDENT VARIABLE	log(GDP per capita, constant 2015 US$)	CONTINUOUS IN NATURE

Independent Variables	**Unit**
Tax Revenue(% of GDP)	Percentage
Labor Force Participation Rate(%)	Percentage
Gross Capital Formation	current US$
Secondary Educational Enrollment	Percentage gross

The Fixed Effects (FE) model was utilized to account for unobserved variability among nations. To verify that the FE model was more suited than the Random Effects model, the Hausman test was employed.

The estimated equation is:

Where is the log of GDP per capita in country i at time t; TAX = tax revenue; LFP = labor force participation; EDU = secondary education enrollment; GCF = gross capital formation; = error term.

$$Y_{it} = \alpha + \beta_1 Tax_{it} + \beta_2 LFP_{it} + \beta_3 EDU_{it} + \beta_4 GCF_{it} + u_{it}$$

5. Analysis and Interpretation A coefficient matrix illustrates the important insights that the regression model produced:

Variables	Coefficient	P- value
Labor force participation rate	.0133	0.000
Secondary Education Enrollment	.0068	0.000
Gross Capital Formation	1.16e-12	0.000
Tax revenue percent of GDP	-.0035	0.281

Regression analysis sheds important light on the macroeconomic variables influencing GDP per capita in the most developed nations in the globe. With a coefficient of 0.0133 and a p-value below 0.01, the labor force participation rate stands out among the variables examined as having a statistically significant and favorable effect on per capita income. From an economic perspective, this means that for every percentage point in-

crease in the labor force participation rate, GDP per capita rises by 1.34%. This research emphasizes the value of inclusive labor market strategies, especially in aging countries where growth depends on retaining and growing the active workforce. Similarly, with a strong statistical significance and a coefficient of 0.0068, secondary school attendance shows a significant impact on income levels. GDP per capita rises by 0.68% for every percentage point increase in enrollment. This emphasizes how important education is for developing human capital, increasing production, raising employability, and stimulating innovation. In order to be competitive in a world that is becoming more and more knowledge-driven, developed economies must prioritize consistent investment in their educational institutions. Despite having a small numerical coefficient of 1.16e-12, gross capital formation is also quite substantial, confirming its importance in economic growth. Through productivity increases and multiplier effects, even small increases in investment in tangible assets—such as machinery, technology, and infrastructure—can result in significant returns.. Long-term development is supported by capital accumulation, which also increases production capacity and draws in private investment. A p-value of 0.281 and a coefficient of -0.0035 for tax revenue as a proportion of GDP, on the other hand, indicate that this variable is not statistically significant in explaining the variation in GDP per capita across high-HDI nations. The nature of tax systems in these countries, where money is frequently directed into welfare and redistributive initiatives rather than straight toward investments that boost growth, may be the reason for this outcome. Furthermore, there are significant differences in the complexity, diversity, and effectiveness of tax systems between nations, which could obscure any consistent correlation with economic production.Additionally, time lags may affect the economic effects of tax policy, lessening its immediate, palpable influence. Overall, the results point to labor, physical capital, and education as the main drivers of income growth in developed nations, whereas taxes have a more complex and indirect effect.

6. Conclusion

The study comes to the conclusion that, among the macroeconomic variables looked at, GDP per capita in high-HDI nations is significantly and reliably predicted by labour force participation, secondary school enrollment, and gross capital formation. These factors highlight how important physical and human capital are to maintaining income growth in developed economies. In the face of demographic shifts, labour force participation—especially that of women, the elderly, and marginalized groups—is essential to sustaining economic productivity. Enrollment in secondary education reinforces this effect by improving labour quality and flexibility, encouraging innovation, and increasing overall efficiency.Gross capital formation promotes long-term growth by boosting firm development and increasing productive capacity through investments in technology and infrastructure.

However, it was shown that there was no statistically significant relationship between tax revenue as a proportion of GDP and GDP per capita. This implies that taxes may have a more redistributive than a productive function in developed economies, with money frequently going into public services and social welfare rather than straight into initiatives that spur economic growth. Any direct relationship may potentially be obscured by complicated tax structures and delayed fiscal repercussions.

These findings emphasize for policymakers the significance of investing in education to create a resilient workforce, fostering capital formation by enhancing the investment climate, and increasing labor participation through inclusive policies. Even if taxes might not have a direct impact on income levels, effective and transparent public spending can assist growth by fostering infrastructure development and human development, which over time will indirectly raise per capita income.

7. Limitations of the Study:

- The study focuses on only four explanatory variables; including more indicators like R&D expenditure, healthcare quality, and environmental sustainability could enrich the analysis.
- The treatment of tax revenue as a single variable ignores important structural differences (e.g., direct vs indirect taxes).
- The 41-year span may include structural breaks (like financial crises and pandemics) that are not explicitly modeled.
- Data availability limited some variable inclusion, and lag effects are not considered.

Despite these limitations, the study offers a robust model for assessing growth determinants in developed economies.

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Book Review

India's Economic Development: Different Dimensions and Perspectives

Edited by: **Dr. Subrata Kumar Ray & Dr. Sovik Mukherjee**

Kunal Books, New Delhi, pp.xviii+240; price INR 995

ISBN:978-93-6389-813-4

This book is a collection of 14 papers presented by eminent scholars of Economics in the Mid-Year National Seminar of Bangiya Arthaniti Parishad, organised by Women's College, Calcutta, West Bengal, in association with Bangiya Arthaniti Parishad. This book is published in 2025 on behalf of Bangiya Arthaniti Parishad (Bengal Economic Association [BEA])in Memory of Dr. Asim Kumar Karmakar, Former President, BEA.

The edited volume *India's Economic Development: Different Dimensions and Perspectives*offers a comprehensive and insightful exploration of India's developmental journey from multiple standpoints. It highlights the complex, multidimensional nature of India's growth and development process. The central theme of the book is to revisit and assess the multiple dimensions and perspectives in which Indian economy, more particularly Indian production-base, has changed and taken the current form in the post independent era. At a time when India stands at the crossroads of rapid economic transformation, global integration, and structural reforms as well as recovery from COVID-19 crises, this volume serves as a timely contribution to academic discourse. It seeks to unravel the diverse economic, social, and institutional factors shaping the country's development trajectory.

The book is carefully structured into five major sections, each addressing a specific dimension of India's socioeconomic development. The Social Dynamism section of the volume traces empowering narratives of Dalits and Tribals as well as challenges for their inclusion in *Viksit Bharat*. The Sectoral Dynamics part of the book focuses on industry and services, especially education as engines of growth. The Socio-economic Challenges section examines inequality and human development. The Eco-environmental Challenges part of the book discusses eco-environmental crises, management and effect of geopolitical risk of climate change. And lastly, the Challenges of Indian Capital Market and Financial Assets- section of the volume assesses the financial crisis in Indian capital

market and impacts of household financial assets on India's growth.

The editors' preface provides an excellent overview of the objectives and the interlinkages among the 14 chapters.Empowering Narratives: The Socio-economic Impact of Dalit Women's Filmmaking in India by Arka Sanyal and Dr. Sudakshina Gupta (Ch.1) explores role of film making and media in the development of Dalit women, emphasizing its significance as a development parameter. Flowers in Thorns: Academic Performance of the Tribal Student in Primary Education: A Study based on ASER Data of Orissa by Atanu Sengupta and Riya Majumdar (Ch.8) reveals that despite improvements in enrollment and infrastructure for tribal education, the quality of education received by SC/ST students continues to lag behind from that of their general category counterparts primarily because of socio-economic barriers, cultural differences and the lack of qualified teachers in tribal regions. Exclusion of Dalits: A Challenge to Viksit Bharat by Afreen Ali (Ch.14) narrates that historical injustices along with present-day challenges underscore the need for the targeted solutions to the systematic inequalities faced by the Dalits in India, and suggests that through inclusion of such deprived communities by providing them proper education, it is possible to attain Viksit Bharat.

Private Sector Involvement in Higher Education in India: A State Level Analysis by Adwaita Maiti and Sebak Kumar Jana **(**Ch.4) focuses on the status of private higher education enrollment of all states and regions in India and the factors influencing private higher education enrolment in India. How Good is the Demand Incentives for Private Electric Car: An Indian Perspective by Debalina Chakravarty (Ch.5) explores the importance of the demand incentives for private electric cars in India s well as identifies the state of consumers' awareness and perception about the demand incentives proposed and offered by the government. Undergraduate Course Selection: Key Factors Influencing Student Choices after Completing Higher Secondary Education in West Bengal by Amit Kundu and Puja Biswas (Ch.11) attempts to identify various households-related, socio-economic and employment-generating factors that influence students' stream choice after the 12th board examination based primary data on 213 students under various institutions of West Bengal using stratified random sampling method.

Human Development Index: Historical Background, Methodology and Measured Values by Siddhartha Mitra and Sriza Chakraborty (Ch.2) firmly declares that human development index incorporating health, education and income is a comprehensive perspective for the measurement of progress, while the index oversimplifies human development by concentrating on limited set of indicators and overlooking critical factors including inequality and security. Impact of Nonfarm Activity on Rural Income Inequality in Nadia District of West Bengal by Dr. Naibedya Prasun Pal (Ch.9) analyses the extent, diversity, inequality and determinants of income of rural households in Nadia District.

India's Waste Management and Environment Sustainability by Dr. Subrata Kumar Ray (Ch.3) highlights India's challenges in waste management, waste market and other related issues. How Does Geopolitical Risk Affect Climate Change?: Evidence from India by Dr. Subhajit Majumder, Biswajit Paul and Somnath Karmakar (Ch.12) analyses the impact of geopolitical risk on climate change, proxied by carbon dioxide (CO2) emissions in India based on time series dataset from 1991 to 2022 incorporating a model for the purpose of analysing the dynamics of the relationship between climate change and considering one of the determinant variables of climate change that is geopolitical risk in India. Management of a Disease Such as COVID-19 in India: The Challenges of a Dependent Economy by Ambar Ghosh and Durba Ahamed (Ch.13) examines how an outbreak of a disease such as COVID-19within and outside India is likely to affect India under free-market conditions using mathematical models as well as aims at to suggest a strategy by means of which it is possible for the Government of India to eliminate such disease having no effective vaccines or medicines.

Volatility Comparison between the 2008 Financial Crisis and the 2020 Stock Market Crash: The Indian Stock Market Story by Dr. Sovik Mukherjee (Ch.6) focus on the indices in financial services, IT, Oil, Gas and FMCG sectors to compare overall volatility fluctuations for the sectors between two stock market crashes, i.e. the 2008 financial crisis and the 2020 stock market crash in Indian context. Financial Assets (Liabilities) of Households and Economic Growth in India: Cointegration and Causality Assessment (by Dr. Tushar Das (Ch.7) provides econometric evidence on the links between the economic growth and changes in financial assets and liabilities of households in India taking the annual time series data for the period 1978-79 to 2020-21.The US Debt Ceiling: Issues and Implications by Sankhanath Bandyopdhyay (Ch.10) narrates that with the reach of upper debt limit in US on 23rd January, 2023, the U.S. President signed the legislation lifting the U.S. debt limit to avoid irreparable harm to the to the U.S. economy as well as to maintain global stability.

This edited collection is remarkable for its interdisciplinary perspective and empirical richness. Several chapters of the book maintain academic depth and offers both theoretical insights and empirical evidence. The editors have successfully integrated diverse voices to present a holistic view of India's development. The use of recent data, comparative analysis, and case-based evidence enhances the academic credibility of the volume. A notable strength lies in the balance between macroeconomic analysis and micro-level case studies, allowing readers to understand both national trends and ground realities. Furthermore, the inclusion of topics such as inequality, environmental concerns, and policy reforms, especially in post COVID-19 crises, makes the volume relevant to current policy debates. However, a few chapters could have benefited from stronger methodological coherence and more robust statistical modeling. Additionally, while the book touch-

es on environmental sustainability, waste management and green growth, these themes could have been expanded further given their rising importance in India's policy agenda. Thus, this volume stands out as a valuable scholarly resource that deepens our understanding of India's developmental path. By combining conceptual clarity with empirical rigor, it offers readers a nuanced appreciation of India's policy challenges and growth opportunities. The book will be particularly useful for students, researchers, economists, and policymakers interested in development studies, public policy, and Indian economy. In sum, this edited volume makes a significant contribution to contemporary literature on India's economic development. The editors deserve commendation for assembling a diverse and insightful collection that captures the complexity, dynamism, and contradictions of India's growth story. Despite minor limitations, the book succeeds in stimulating critical thought and opens new avenues for future research on inclusive and sustainable development.

Dr. Gopal Chandra Mandal

Associate Professor in Economics

Prabhu Jagatbandhu College, Howrah

ICSSR-ERC sponsored Two day 45th Annual conference of Bangiya Arthaniti Parishad (Bengal Economic Association (BEA) on "Economics of Gender and Health: Lessons from India during Post-Pandemic Era" organized by BEA in collaboration with Department of Economics, Murshidabad University during 18th& 19th March , 2025 at Murshidabad University : A Report

The Bangiya Arthaniti Parishad (BAP) in collaboration with Murshidabad University (MU) had organized for the first time an ICSSR-ERC sponsored two day 45thAnnual conference of B.A.P. at MU on " Economics of Gender and Health : Lessons from India during Post Pandemic Era:" . This is the first time for BEA in its history to hold a Annual conference at MU, West Bengal.

The first day session started at 10 AM under the chairmanship of Dr.Anupama Chowdhury , Principal, Women's College, Calcutta . After National Anthem , Lighting of the Lamp, felicitation of guests, welcome address was delivered by Dr.Rajib Mukherjee , Registror, MU . After the welcome address , prof(Dr) Zane alam , the vice-chancellor of MU delivered the Inangural address. After inangural address, other speech/addresses were happened.

Dr. S. N. Sen memorial lecture was delivered by Prof(Dr)Atanu Sengupta , Department of Economics Burdwan University . Dr Asim K Karmakar memorial lecture was delivered by Dr.BuddhenSalkia , H.O.D of Economics , Morigaon College , Gauhati University . Special lectures were delivered by 1) Dr, DibyenduMaity, Delhi School of Economics, 2) Dr.Sudip Jana, Vice-President , BEA,

After the lunch break , the technical sessions were started.

On the day, the special lectures were delivered by 1) Dr.Subrata Kumar Ray, Secretary , BEA 2) Dr.Achiranshu Acharya , Professor of Economics, VisraBharati University,(VBU),3) Dr.Apurba Chattapodhyay ,Professor of Economics (VBU), 4) Dr.Subhojit Majumdar, and Dr. Krishna Singh, Department of Economics, Gour Banga University(GBU), 5) Dr.Sushmita Chatterjee, Assistant Professor, Department of Economics, Maharaja Manidranath College.

After the Lunch Break the Technical sessions were started .

After the completion of Technical sessions, the valedictory session & certificate distribution were organized.

Dr. Subrata Kumar Ray

Secretary

Bangiya Arthaniti Parishad

Report of the ICSSR-ERC sponsored two day National Seminar organized by Vidyasagar College (Day), Kolkata in collaboration with Bangiya Arthaniti Parishad on 25th and 26th April, 2025.

It is a great pleasure for me to report that a National Seminar on issues in growth and development Dynamics of Indian Economy- The post reform Era organized by Vidyasagar college (Day), Kolkata in collaboration with Bangiya Arthaniti Parishad during 25-26th April, 2025. Dr. Surajit Das, CESP, JNU, New Delhi has delivered the inaugural address. Dr. Natasa Dasgupta, Principal, Vidyasagar College (Day), Kolkata has given welcome address. The speech has also delivered by Dr. Nirmalendu Mukhoti, IQAC co-ordinator, Dr. Shyamalendu Chatterjee, President, Bangiya Arthaniti Parishad (B.A.P.), Dr. Sudip Jana, Vice-President, B.A.P., Dr. Subrata Kumar Ray, Secretary, B.A.P., Prof. Chiranjib Bhattacharjee, President, W.B. Council of higher Secondary Education, Prof. Soumen Sikdar, Smt. Subhra Dey, President Governing Body, Prabhu Jagatbandhu College. We have felicitated Prof. Pabitra Sengupta, Former Secretary B.A.P. and Prof. Basabi Bhattacharya, Former Professor, department of Economics, Jadavpur University, Kolkata. Inaugaral Session has been chaired by Dr. Natasa Dasgupta, Principal, Vidyasar College (Day) Kolkata.

The session-I of day one (25th April, 2025) was chaired by Dr. Sasswati Sanyal, Principal, Rammohan College, Kolkata and co-chair by Dr. Moitrayee Ghosh, Joint DPI and OSD, Govt. of West Bengal. Prof. Sovik Mukherjee, Assistant Prof. of St. Xaviar University, Kolkata, has acted as rapporteur. The Keynote speech has been delivered by Prof. Rajat Acharya, Department of Economics, Jadavpur University. Dr. A.K. Dasgupta memorial lecture has been delivered by Prof. Anjan Chakroborty, Department of Economics, Calcutta University, Kolkata.

In session-II, the special; lectures have been delivered by prof. Soumen Sikder, Former Professor, IIM, Kolkata and Prof, Mahalaya Chatterjee, Department of Economics, Calcutta university. This session has been chaired by Dr. Mnideep Chandra, Principal, Shibpur Dinobondhu Institution (college) and co chaired by Dr. Purba Chattopadhayay, Associate Prof. Department of home Science, Unbiversity of Calcutta. Dr. Anadita Dawn, SACT-I, Prabhu Jaghatbandhu College, Howrah has acted as raporteur.

In technical session-III, Prof. Kalyan Sanyal memorial lecture has been delivered by Dr. Surajit Das, CESP, JNU, New Delhi. Dr. Indrila Guha, Principal, Basanti Devi College, Kolkata, has delivered a special lecture.

Technical session-I was Chaired by Dr. Susmita Banerjee, Associate Professor in Economics, Charuchandra College, Kolkata and Co-chaired by Dr. Arpita Mondal Nandi, Principal, Panchala Mahavidyalaya, Howrah. Mr. Tapan Purokait SACT, Department of Commerce, Netajee nagar day college , Kolkata has acted as rapporteur. In this session five research papers have been presented.

Technical session-II has been chaired by Dr. Sonali Banerjee (Josh), Principal, Netajee Nagar Day college, Kolkata and Co-chaired by Dr. Goutam Kumar Sarkar, Associate Professor, Department of Economics, Jogamayadevi College, Kolkata. Dr. Gopal Chandra Mondal, has acted as rapporteur. In this session five research papers were presented.

Technical session-III has been Chaired by Dr. Sanghamitra Bramha, Amity Business School, Amity University, Kolkata and Co-chaired by Dr. Suparna Gangoppadhyay, Department of Economics, Surendranath College for women, Kolkata. Arka Sanyal, SACT, Department of Economics, Prabhujagatbandhu College, Howrah. Six research papers have been presented in this session.

In day two, session-I has been chaired by Dr. Subrata Kumar Ray, Principal, Prabhu-Jagatbandhu College, Howrah and Co-chaired by Dr. Sudip Jana, Vice President, BAP. Dr. Susmita Chaterjee, department of Economics of MM Chandra College Kolkata has acted as raporteur. Special lecture has been delivered by Dr. Tarun Kabiraj, ERU Indian Statistical Instute, Kolkata.

Session-II has been chaired by Dr. Sarmita Dhar of Sreerampore college Hooghly and cochaired by Dr. Amrita Majumder, Deputy Register and associate professor, Amity University, Kolkata. Dr. Tushar Das of BAP has acted as rapporteur.

Special lectures have been delivered By Prof. Sudakshina Gupta of derpartemnt of economics, Calcutta University aand Dr. Anupama Chowdhury, Principal, Wommen's College, Kolkata.

Session-III has been chaired by Dr. Sakhi Roy of Amity School of Economics, Amity University, Kolkata and Co-chaired by Dr. Sunanda Goenka, Principal, JCC Law college, Kolkata. Prof. Jaba Pal Chatterjee has acted as rapporteur. Special Lectures have been delivered by Prof. Achiranshu Achayra, Department of economics Viswabharati University and Prof. Arijita Dutta, Department of Economics, Calcutta University.

Session-IV has been chaired by Dr. Debasis Majumder, Department of Economics. The Heritage College, Kolkata and Co-chaired by Dr. Himadri Bhattacharyya Chakrabarty, Principal, Bangabasi College, Kolkata. Prof. Arpita Chakraborty, Department of Economics, Vidyasagar College has acted as rapporteur. Special lectures have been delivered by Prof. Basabi Bhattacharya, Former Professor of Finance, Department of Economics,

Jadavpur University, Kolkata and Dr. Manmeet Kaur, Associate Professor of O.P.Jindal Global University, New Delhi.

Session-V has been chaired by Prof. Siddhartha Mitra, Department of Econimics, Jadavpur University and Co-chaired by Dr. Prabal Dasgupta, Professor of Economics, Acharya Girish Chandra Bose College, Kolkata. Mrs. Patralika Bhattacharya, Assistant Professor in Economics, Sister Nivedita University, Kolkata has acted as rapporteur. Special lectures have been given respectively by Prof. Ambar nath Ghosh and Dr. Rajagopal Dhar Chakraborty.

Technical Session-I was Chaired by Dr. Indrani Banerjee, Associate Professor, Department of Economics, St. Paul's Cathedral Mission College, Kolkata and Co-chaired by Dr. Rajib Prasad, Assistant Professor, Assistant Professor, Department of Economics, Vidyasagar College for Women, Kolkata.

Technical Session-II was Chaired by Ishita Chakravarty, Associate Professor, Department of History, Vidyasagar College, Kolkata and Co-chaired by Dr. Avishek Biswas, Assistant Professor, Department of English, Vidyasagar College, Kolkata. Dr. Monisankar Sarbabidya has acted as rapporteur. Six research papers have been presented in the session.

Technical Session-II was Chaired by Prof. Jayanta Sen, Department of Economics, West Bengal State University and Co-chaired by Dr. Susmita Chatterjee, Assistant Professor, Department of Economics, Maharaja Manindra Chandra College, Kolkata. Mr. Samrat Chatterjee, Department of Commerce, Bhawanipur Education Society College, Kolkata has acted as rapporteur. Four research papers have been presented in this technical session.

Technical Session-IV was Chaired by Prof. Khitish Kumar Kunthia, Department of Economics, Amity Business School, Amity University, Kolkata and Co-chaired by Dr. Nabanita De, Department of Economics, Charuchandra College, Kolkata. Dr. Namrata Ray of St. Xavier's College has acted as rapporteur. Three research papers have been presented in this technical session.

Seminar ends with vote of thanks by the convener.

Dr. Subrata Kumar Ray

Secretary

Bangiya Arthaniti Parishad

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Srija Chatterjee, SACT, Department of Sociology, Prabhu Jagatbandhu College, Howrah.
Dr. Tushar Das, Headmaster, Sadananda Mission High School, Howrah.

Co-Opted Members : Shri Tapan Purkait, SACT, Dept of Commerce, Netaji Nagar Day College. Kolkata.
Dr. Yojna Khraga, Assistant Professor in Economics, Kalimpong College, West Bengal.

Special Invitees : Dr. Debasis Mukhopadyay, Principal, Sreegopal Banerjee College Hooghly, West Bengal.
Shri Somnath Karmakar, Research Scholar, Dept. of Economics, University Of Gour Banga.

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