Multivariate Statistical Analysis of the Drivers of Women's Empowerment in Labor Market

Drishtanti Saha, Pratik Sarkar, Markus Holz, Cornelia Scott and Halina Falfushynska
Anhalt University of Applied Sciences, Strenzfelder Allee 28, 06406, Bernburg, Germany
{Drishtanti.Saha, Pratik.Sarka}r@student.hs-anhalt.de, {markus.holz, cornelia.scott, galyna.falfushynska}@hs-anhalt.de

Keywords: Female Labor Force Participation, Education and Employment, Maternal Health, Gross National Income per Capita, Gross Domestic Product.

Abstract: The current study seeks to explore the time series perspective of Indian women's involvement in available work seasoned with other factors determined for their employment from 1991 to 2023. Using some sophisticated statistical techniques, such as Regression models, Principal Component Analysis and Partial Least Squares-Discriminant Analysis, the research showed that the reduction of the number of deaths of children under the age of one year per 1000 live births has been a major contributing factor in the increase in the percentage of women participating in the labor force. In addition, economic advancement, maternal death rates, and life expectancy were also relevant in determining these trends. From 1991 to 1999, factors such as the lifetime risk of maternal mortality, the increasing number of women with lower levels of education participating, and changing economic conditions were critical in determining the extent of women's labor force participation. From 2000 to 2009, more women graduates began to join the labor force as every society begun to change gradually. From 2010 to 2019, the growth of GNI per capita and increasing expansion in women participation in the labour force paid dividends. This research highlights the importance of continued socio-economic progress in promoting gender equality in employment.

1 INTRODUCTION

Rise in female labour force participation is a significant economic transformation of the previous century. Historically, men have participated in labour markets more frequently than women worldwide, but this participation landscape is rapidly evolving. The global labour force participation rate for women is currently less than 47%, whereas for men it is 72% [1].

Considerably in particular regions, this gap reaches 50%, underscoring the persistent challenge of attaining gender equality in the labour market. It is believed that female labour force participation rates are higher in many of the world's poorest and highest-income countries based on several factors [2].

Although India ranks as the fifth-largest economy globally by nominal GDP and the third-largest by purchasing power parity (PPP) [2] its female labour force participation rate was very low at approximately 37% in 2022 [3] which is significantly below the global rate.

The dynamics of female labour force participation in India represent a complex interaction of socio-economic factors, illustrating the multifaceted nature of the quest for equal opportunity. In contrast to the generally observed linear models of structural transformation, India's economic narrative reveals a distinct trajectory [4], wherein the anticipated growth in the manufacturing sector did not occur following the collapse in agriculture. The services sector predominantly accommodated the economic shift, witnessing significant expansion over the past twenty years. However, this economic progress has not been directly reflected in employment possibilities, notably impacting women.

Evidence demonstrates that empowering women not only offers individual advantages such as decreased fertility rates and postponed marriage but also serves as an indicator of wider developmental results. Following 2019, a significant rise in the female labour force participation corresponds with the consistent increase in India's Gross National Income (GNI) per capita [5] indicating a mutually reinforcing link that may support progress in

women's education and entrepreneurship. This synergy underscores the transformative potential of targeted policies in fostering both economic growth and gender equality.

The study aims to explore the dynamics of female labor force participation in India, highlighting the complex socio-economic, cultural, and policy factors that influence women's employment. The research investigates how these factors interact to impact gender equality in the labor market and assesses the broader economic implications.

2 MATERIALS AND METHODS

For this statistical analysis we have collected data from the central repository of World Bank Database [6].

The main variable of interest includes Labor force female, Expected years of schooling for female students, Expected years of schooling for all gender students, Female labor force with different levels of education, and Gross national income in terms of PPP. The dependent variable was considered to be the count of labor force female and we have analysed how other crucial factors in a socio-economic environment effects its variations from year to year and in some cases among decades. Expected year of schooling for all genders and especially for female have been analysed as two separate variables to observe their independent effects on the dependent variable. The independent variable 'Infant Mortality Rate' is defined as the number of live births per thousand people per year. Independent variable named 'GNI per Capita in terms of PPP' is measured on current US Dollar. 'Lifetime Risk of Maternal Death' this independent variable is measured in a scale of hundred.

Data cleaning and pre-processing are routinely performed on the collected information. To prevent inaccurate interpretations, all indicators with missing values were excluded from subsequent analyses. Normality and homogeneity of variance were assessed using the Kolmogorov–Smirnov and Levene's tests, respectively. Data were adjusted using the Box–Cox transformation method whenever possible. To analyse possible relation between parameters correlation heatmap based on Pearson correlation test was created. To determine which parameters significantly affect Labor Force Female multiple regression was performed. Normalized, auto-scaled data underwent principal component analysis (PCA) to distinguish individuals based on their personal traits. PCA is the conventional method for component extraction and for visualizing the similarities among samples. It aims to identify a low-dimensional representation of the data that combine the majority of the variance. Only variables exhibiting a correlation greater than 0.60 with the first two dimensions of the PCA (Factor Loadings) have been included. Statistical calculations were performed using MetaboAnalyst v. 6.0 (https://www.metaboanalyst.ca/) and MS Excel 365 with Data Analysis ToolPak. Google Sheet machine learning algorithm was used to predict the missing values for unavailable data points based on other available datasets.

3 RESULTS AND DISCUSSION

The findings from the correlation and regression analysis pointed the complex interactions among socio-economic and demographic factors, highlighting their combined impact on female labour force participation. The correlation matrix (Fig. 1) demonstrates interrelated associations among principal indicators. The positive correlation between female life expectancy at birth and expected years of schooling for females underscores the interdependent relationship between educational achievement and health consequences.

Furthermore, GDP Per Capita (PPP) exhibits a positive correlation with both Life Expectancy ($r = 0.366$, $p<0.01$) and Female Labor Force Participation ($r=0.405$, $p<0.01$), emphasizing the role of economic expansion in enhancing living standards and fostering women's involvement in the labor market.

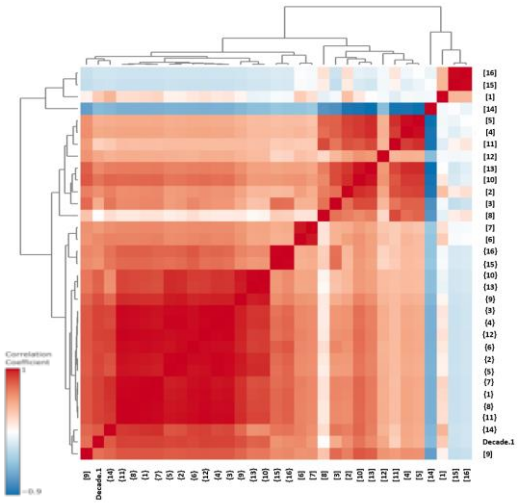

Figure 1: Correlation Heatmap.

The number and their corresponding variable names are as follows: [1]-Labor force female percentage of total labor, [2]-Labor force female, [3]-Employers female, [4]-Expected years of schooling for all genders, [5]-Expected years of schooling for female, [6]-Labor force female with basic education, [7]-Labor force female with advanced education, [8]-Life expectancy at 60 for female, [9]-Paid maternity leave length calendar days, [10]-GNI per capita in PPP($), [11]-Life expectancy at birth years, [12]-Government expenditure in education percentage of GDP, [13]-GDP growth per capita, [14]-Mortality rate of infant per 1000 live births, [15]-Lifetime risk of maternal death percentage, [16]-Number of maternal deaths, {1}-Average of LFF percentage of total labor, {2}-Average of Labor force female, {3}-Average of employers female, {4}-Average of expected years of schooling, {5}-Average of expected years of schooling for female, {6}-Average of LFF with basic education, {7}-Average of LFF with advanced education, {8}-Average of life expectancy at 60 for female, {9}-Average of paid maternity leave length in calendar days, {10}-Average of GNI per capita PPP($), {11}-Average of life expectancy at birth years, {12}-Average of Govt expenditure in education as percentage of GDP, {13}-Average of GDP growth per capita, {14}-Average of mortality rate of infant per 1000 live births, {15}-Average of lifetime risk of maternal death percentage, {16}-Average of number of maternal deaths.

Conversely, the negative correlations exhibited by variable such as the Mortality Rate (Infant Per 1000 Live Births) ($r=-0.499$, $p<0.001$) and positive correlations with expected years of schooling for a female ($r=+0.765$, $p<0.01$) with Life Expectancy and Educational Outcomes suggest the adverse effects of poor health metrics on socio-economic development can be improved by increasing the average study period for a woman. Further, Government Expenditure on Education is positively correlated with educational and health variables (Fig. 1), emphasizing the importance of public investment in nurturing human capital. Similar findings were pointed for South Asia countries in general [7]. In particular, a one percent increase in trade openness results with a 0.0152% rise in female employment, and empirical data supports long-term cointegration among education, trade, urbanization, male labor-force participation, per capita income, and employment. Also, 10% increases in the work parity index score were significantly associated with a decrease of 14.6 maternal deaths per 100,000 live births and an increase of 0.9 years in female life expectancy at birth, independent of county income level [8]. Therefore, public investment in education and work parity is essential, as government expenditure is positively correlated with improved educational and health outcomes. This tendency is consistent across different regions, regardless of a country's income level, reinforcing the concept of integrated growth strategies.

The Multi-Linear Regression analysis enhances these data by elucidating the degree, direction, and statistical significance of each variable's impact on socio-economic outcomes. The preliminary regression study, covering the period from 1991 to 2023 and omitting two maternal health variables, reveals a strong model with an R-squared value of 0.952, with Gross National Income (GNI) per Capita identified as a substantial positive factor influencing socio-economic outcomes:

Labor Force Female = 191959083 - 1621217.78×Expected Years of Schooling + 447867.24×Expected Years of Schooling Female + 231179.21×Life Expectancy at 60 Female - 90388.28×Paid Maternity Leave Length + 14558.93×GNI per Capita* - 194442.39×Life Expectancy at Birth - 1781077.94×Govt. Expenditure in Education - 40717.61×GDP Growth Per Capita* -1064582.39×Mortality Rate, $F = 50.816$, $R^2 = 0.952$ (* indicates a parameter that has a significant effect on the Labor Force Female as the dependent variable, with $p<0.05$).

At the same time GDP Growth per Capita shows a significant, albeit negative, relationship, suggests that while economic growth generally enhances overall living conditions, it can also contribute to disparities in specific contexts. In developing countries, for instance, high female labor force participation rates are often associated with economic hardship rather than empowerment [9], as many women enter the workforce out of necessity rather than choice. Moreover, while the gender gap in labor market participation tends to be smaller in developing economies compared to high-income countries [10], women in these regions are more likely to be employed in lower-paid jobs. This is largely due to limited access to education and skill development opportunities, which constrains their upward mobility within the labor market.

These findings highlight the crucial role of education in optimizing female labor market participation. By improving educational attainment among women, not only can their employment prospects and earnings potential be enhanced, but they may also gain greater societal recognition and agency. In the long run, such improvements could significantly improve economic growth. Notably, if all other factors remain constant, a 1% increase in female labor force participation is estimated to contribute to a 3.06% rise in overall economic growth [11].

Enhancing the analysis from 2000 to 2023, by incorporating the Percentage of Lifetime Risk in Maternal Death and the Count of Maternal Death, elucidates the intricate influences of maternal health indicators, offering a revised perspective that mirrors current trends and healthcare progress. The revised model demonstrates a robust fit, with a R^2 value of 0.986, highlighting the significance of GNI per capita and infant mortality rate as key predictors.

Labor force female = - 188965438 - 1904267×Expected Years of Schooling + 4207734×Expected Years of Schooling Female - 2237822×Life expectancy at 60 Female + 42365×Paid Maternity Leave Length + 16892×GNI Per Capita* + 2277591×Life Expectancy at birth - 47943×Govt Expenditure in education - 13243×GDP growth per capita + 3015358×Mortality rate infant* + 121705×Lifetime risk of maternal death - 529×Number of maternal deaths. $R^2 = 0.986$, $F = 78.475$, $p = 0.05$ (* indicates a parameter that has a significant effect on the Labor Force Female as the dependent variable, with $p<0.05$)

The analysis of Indian households reveals parallels with observations from other areas, such as Kenya, where financial strains associated to healthcare and the loss of essential family members significantly affect households [12]. In India, economic pressures compel households to reallocate resources and time, frequently resulting in women managing significant home responsibilities alongside income generation. Based on these ideas, policies like improving access to financial safety nets, promoting female labor participation, and strengthening healthcare facilities are crucial for alleviating economic shocks and creating sustained socio-economic growth.

Recognizing that PCA provides a more comprehensive synthesis by reducing the dataset's dimensionality and highlighting the most influential variables, we applied this technique and identified two principal components with the highest eigenvalue that represent the total amount of variance that can be explained by a given principal component. Two PCs account for 62.69% and 14.26% of the total variance in the dataset. The biplot analysis illustrates socio-economic and temporal trends in the dataset (Fig. 2).

These clusters reflect temporal changes, with the data for earlier years (1990 and 2000) distinctly separated from later years (2010 and 2020). This suggests that significant shifts occurred in the underlying variables over time. For example, indicators such as life expectancy, education levels, and mortality rates may have improved over the decades, as suggested by the clustering pattern and the positioning of observations along PC1. PC2, in turn, highlights gender-specific labor dynamics, influenced by variables such as female employers and female labor force. PC1 captures disparities in socio-economic development, with strong positive correlations observed for variables like life expectancy at birth for a new born and GDP growth per capita while average schooling years for a woman shows a negative correlation, reflecting its association with lower socio-economic progress.

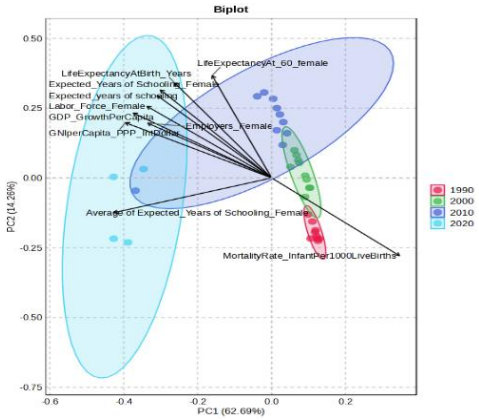

Figure 2: PCA Analysis of socio-economic and temporal parameters that affect Labor force female

Temporal analysis reveals that 2020 observations align with improved indicators, including higher GDP per capita and life expectancy, whereas 1990 data is associated with higher infant mortality rates. This indicates significant socio-economic and health progress over time.

In India, family is the major social unit, and all the important decisions in the family are made by the head of the household. Therefore, it is important to know how the education of women affects family-related issues [13]. All these factors contribute directly or indirectly to the working habit of a woman in a society like India. Increased family planning to reduce the unmet need (for spacing and limiting births) by amounts ranging from 25% to 100%, reduced maternal deaths by amounts ranging from 7.0% to 28.1% in rural India and 5.8% to 23.5% in urban India. In rural India, eliminating the unmet need for family planning decreased the TFR (Total Fertility Rate) from 2.97 to 2.14, the proportion of deaths that are pregnancy related from

16.4% to 12.3%, and the lifetime risk of maternal death from 1 in 65 to 1 in 90 [14].

Over the past two decades, government expenditure on education as a percentage of GDP has been a key driver of female labor force participation in India, enabling access to quality education, skill development, and economic empowerment. Despite the *Prevention of Child Marriage Act 2016*, early marriages persist, but women marrying after 21 years fare better in employment and earnings. Increasing education levels have also fuelled a rise in female entrepreneurship, with India ranking as the most active country for women entrepreneurs, particularly in manufacturing [15]. Life expectancy further impacts women's workforce participation by encouraging long-term investment in skills and improving health outcomes. Together, these factors foster socio-economic empowerment, transforming women's roles in economic and social development [16].

4 CONCLUSIONS

The progression of women's labor force participation in India from 1991 to 2023 underscores a complex interaction of socio-economic, cultural, and policy influences. Health and education have become essential factors influencing female labor force participation. Decreases in infant mortality rates and enhancements in maternal health have been associated with greater workforce inclusion. Access to higher education has equipped women with skills and confidence, facilitating their transfer from agriculture to industry and services, where formal work opportunities are expanding.

Economic factors such as GNI per capita and GDP growth have impacted women's labor force participation, although rural regions have persistent structural obstacles. Economic progress has broadened options, especially in entrepreneurship; nonetheless, cultural norms and gender biases persist in constraining women's potential. Policy interventions in education, healthcare, and maternity leave have yielded beneficial outcomes; nevertheless, their effectiveness is compromised by implementation deficiencies, particularly in marginalized areas. Cultural influences, such as familial arrangements, substantially influence workforce involvement, with Hindu women experiencing comparatively greater autonomy.

ACKNOWLEDGMENTS

This research was funded by the BMBF Project "Professor*innengewinnung und Nachwuchsentwicklung zur Etablierung eines Centers of Advanced Scientific Education (CASE).

Also, we acknowledge support by the German Research Foundation (Deutsche Forschungsgemeinschaft, DFG) and the Open Access Publishing Fund of Anhalt University of Applied Sciences.

REFERENCES

[1] "Keys to understanding the world of work," [Online]. Available: https://webapps.ilo.org/infostories/en-GB/Stories/Employment/barriers-women#global-gap, [Accessed: 15 May 2025].

[2] "Our World in Data – Women's Employment," [Online]. Available: https://ourworldindata.org/female-labor-supply, [Accessed: 15 May 2025].

[3] "Economy of India," [Online]. Available: https://en.wikipedia.org/wiki/Economy_of_India, [Accessed: 15 May 2025].

[4] R. Lahoti et al., "Economic development and female labor force participation in India," IIM Bangalore Research Paper, no. 414, 2013.

[5] A. Costagliola, "Labor participation and gender inequalities in India: Traditional gendernorms in India and the decline in the Labor Force Participation Rate (LFPR)," The Indian Journal of Labour Economics, vol. 64, no. 3, pp. 531-542, 2021.

[6] "World Bank Group | Gender Data Portal – India," [Online]. Available: https://genderdata.worldbank.org/en/economies/india#:~:text=In%20India%2C%20the%20labo, [Accessed: 15 May 2025].

[7] L.C. Voumik et al., "The impact of female education, trade openness, per capita GDP, and urbanization on women's employment in South Asia: application of CS-ARDL model," Systems, vol. 11, no. 2, p. 97, 2023.

[8] "Gender parity at scale: Examining correlations of country-level female participation in education and work with measures of men's and women's survival," [Online]. Available: https://www.thelancet.com/journals/eclinm/article/PIIS2589-5370(20)30043-2/fulltext, [Accessed: 15 May 2025].

[9] "Female Labor Force Participation in Developing Countries," IZA World of Labor, no. 87, 2014, [Online]. Available: https://wol.iza.org/articles/female-labor-force-participation-in-developing-countries/long, doi:10.15185/izawol.87.

[10] International Labour Organization, "Economic Impacts of Reducing the Gender Gap," What Works: Research Brief No. 10, 2017, [Online]. Available:

https://www.ilo.org/media/422531/download, [Accessed: 15 May 2025].

[11] R. Akhtar et al., "Economic growth, gender inequality, openness of trade, and female labour force participation: A nonlinear ARDL approach," Economic Change and Restructuring, vol. 56, no. 3, pp. 1725-1752, 2023.

[12] A. Kes et al., "The economic burden of maternal mortality on households: evidence from three sub-counties in rural western Kenya," Reproductive Health, vol. 12, p. 1-10, 2015.

[13] K. Borkotoky et al., "Female education and its association with changes in socio-demographic behaviour: evidence from India," Journal of Biosocial Science, vol. 47, no. 5, pp. 687-706, 2015.

[14] S.J. Goldie et al., "Alternative strategies to reduce maternal mortality in India: a cost-effectiveness analysis," PLoS Medicine, vol. 7, no. 4, p. e1000264, 2010.

[15] R. Singh et al., "Exploring Reasons for Low Female Labour Force Participation in Regular Salaried Jobs: Evidence from Young Lives Longitudinal Study in India," Indian Journal of Human Development, vol. 16, no. 2, pp. 267-285, 2022.

[16] S. Manshani et al., "Startup women in startup India: A study of women entrepreneurs in India," International Journal of Business Management (IJBGM), vol. 6, no. 4, pp. 91-100, 2017.