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Deciphering the Enigma: A Multi-Dimensional Study of Female Labour Force Engagement and Predictive Drivers

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Abstract

This study explores the multifaceted relationship between female labour force participation and crucial socio economic indicators against the backdrop of the multi-dimensional history of female labour force participation in India throughout the course of the 20th century. This research integrates secondary data encompassing per capita GDP, female gross secondary enrollment, fertility rates, and infant mortality rates using precise data collected from 1991 to 2022, obtained from The World Bank's extensive repository. The cornerstone of our analysis is an apparent inverted U-shaped pattern that appears to be typical in developing countries throughout the early stages of growth. Unquestionably, projected numbers show a clearly diminishing trend in female labour force participation (FLFP) throughout the time. Granger causality analysis unveils complex relationships, notably highlighting the substantial influence of female secondary education in promoting labour involvement, albeit unidirectional. Additionally, FLFP Granger causes per capita GDP, underlining its role in economic growth. These insights offer invaluable guidance for policymakers in advancing gender equality and sustainable development, contributing to a more inclusive and prosperous future.

Key words: Women labour, Female participation, GDP, Secondary education.

JEL Classification: J16, J43, J82, E24.

Introduction

India's labour force is, like a tapestry. When we look at the history of female participation in the workforce during the 20th century, we see a rich and diverse story. Female labour force participation goes beyond numbers; it represents contributions as well as social equality and human progress. Throughout times women in India have played roles alongside men, in different economic activities showing impressive efficiency. However, the dynamics of female labour force participation changed as India through revolutionary phases characterized by independence, industrialisation, and urbanization. These changes boosted women's educational prospects and empowered them, allowing them to pursue careers in a variety of fields like technology, healthcare, and entrepreneurship.

Nevertheless, the paradox emerges as, despite significant advancements in female education, labour force participation rates began to plateau and even decline in certain regions by the century's end. Furthermore, it's imperative to recognize that, when juxtaposed against developed nations such as China and the United States, India's female labour force participation remains lower. This decline reflects a complex interplay of factors, including persistent gender-based cultural norms, workplace discrimination, and the persistence of gender roles in family structures. Furthermore, the share of women in salaried jobs in the country remains lower than in the rest of the world. When it comes to educational access, India ranks last, with the lowest school enrolment for girls not only in comparison to developed nations, but even in comparison to neighbouring less developed countries like Nepal and Bangladesh.(Source: Worldbank). The study has been undertaken to explore the relationship between female labour force participation (FLFP) and per capita GDP ;to construct a predictive model for FLFP over the ten-year span from 2023 to 2032 and to examine the feasibility of forecasting FLFP utilizing indicators including secondary enrolment in education, infant mortality rates, per capita GDP, and fertility rates.

Data Sources and Methodology

Data was meticulously gathered from 1991 to 2022 for this analysis, gathering important information from The World Bank's large data repository. The study is based on secondary data on per capita GDP, female gross secondary enrolment, fertility rates, and infant mortality rates. Per

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capita GDP was chosen as the primary economic indicator for its correlation with female labour force participation. Logarithmic transformation for per capita GDP is used to improve the statistical robustness of our analysis. This alteration had a pair of objectives: first, it addressed potential skewness in the data, ensuring that our research was methodologically sound. Second, it efficiently handled the dataset's nonlinearity, allowing for a more precise analysis of the relationship between per capita GDP and female labour force participation.

Time series data analysis is the main methodological strategy used in the present study. The researcher has developed a fundamental model in the pursuit of our first objective, which is to elucidate the relationship between FLFP and a key economic indicator, more specifically, GDP per capita. The model structure, rooted in prior scholarly research, is expressed as follows:

$$Y = \alpha + \beta_1 X_1 + \beta_2 X_2^2 + e$$

Y = Female Labour Force Participation rate (the dependent variable).

X_1 = Independent variable representing the level of economic development, wherein GDP is employed in the form of log GDP per capita.

X_2^2 = Squared logarithmic term of GDP.

β = Estimated coefficient denoting the respective regression relationship, elucidating how variations in the independent variable impact the dependent variable.

α = Constant term.

e = Random error term.

To underpin our modelling approach, we conducted an exhaustive review of relevant scientific literature and scholarly articles. The chosen model makes use of linear regression techniques, and the regression analyses were carried out with the help of the Desmos graphing calculator. In order to achieve our second objective, which is to anticipate FLFP over a ten-year period, we used the Auto-Regressive Integrated Moving Average (ARIMA) forecasting approach, facilitated by the EViews software. For our third objective, which intended to assess the viability of forecasting Female Labour Force Participation by incorporating various range of indicators, which includes secondary enrolment in education, infant mortality rates, per capita GDP, and fertility rates—we employed the Pairwise Granger Causality Test, through the EViews software. This rigorous analytical approach allows us to probe the causal relationships (Unidirectional or Bidirectional) between the mentioned indicators and FLFP, contributing to a comprehensive understanding of the factors influencing female labour force participation. Furthermore, stationarity was diligently verified through the Augmented Dickey-Fuller test to ensure the validity of our model in both second and third objective.

Results and Discussion

Table 1 offers a comprehensive presentation of the regression outcomes derived from the foundational model. As expected, the logarithmic transformation of GDP exhibits a positive coefficient, while the squared logarithmic term of GDP yields a negative coefficient. These empirical findings affirm the existence of an inverse U-shaped relationship between economic development, denoted by log GDP per capita, and female labour force participation. This pattern is a typical one that is frequently seen in developing countries in the early stages of their economic development.

Notably, these results support the theory that, for example, India is currently experiencing a fall in female labour force participation. Both urbanization and mechanization of agriculture, which are repercussions of economic progress, are blamed for this loss. In addition, economic progress frequently results in lower rates of poverty and higher incomes, which encourages women to leave the agricultural sector. They might redirect their efforts on taking care of their families, continuing their education, or looking for more lucrative career prospects.

Coefficient of determination (R-squared) of the model is impressively close to 90 per cent indicating that adding GDP per capita as an independent variable may explain almost 90per cent of the variation in FLFP.

Table 1: Regression result

Variable	Coefficient	P > | t |
Log (GDP)	β_1 = 174.43	0.000
Log (GDP)^2	β_2 = -31.24	0.000
R squared	0.8932	
α	-212.87	

The association between FLFP and economic development, represented in terms of GDP per capita, is graphically depicted in Figure 1, which was generated from the fundamental model. The causal relationship between the female labour force participation rate (%) and GDP per capita is inversely U-shaped, as seen in the graph, and there is a clear negative correlation. It is important to highlight that the 1991–2022 time period is explicitly covered by the graphical representation in Figure 1.

In the context of our meticulous time series analysis, the discerning choice emerged as the ARMA(0,0)(0,0) model augmented with first differencing (d=1), thoughtfully derived through an exhaustive automatic ARIMA procedure, with a keen emphasis on optimizing the Akaike Information Criterion (AIC).The ARMA(0,0)(0,0) designation embodies a model characterized by the absence of autoregressive (AR) or moving average (MA) components, both in historical observations and preceding forecast errors. Notably, as illustrated in Figure 2, our selected ARMA (0,0)(0,0) model

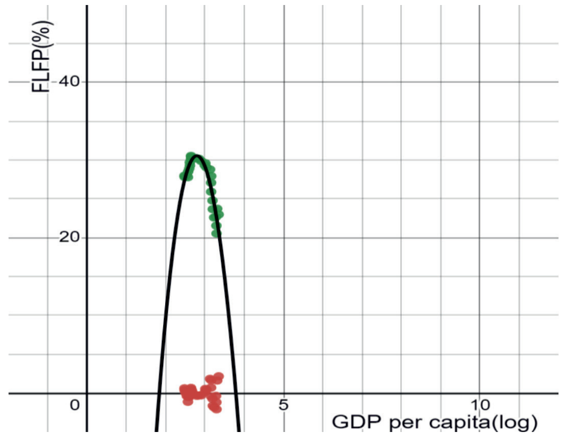

Figure 1 : Female labour force participation and GDP per capita

exhibits the lowest AIC , BIC and HQ values. when compared to alternative models, robustly validating its selection. The forecasted values, meticulously tabulated in Table 2, offer a comprehensive view of our predictions. Subsequently, upon visualization in Figure 3, these forecasted values unequivocally unveil a discernible downward trajectory in female labour force participation across the years. The narrative is elegantly conveyed by the blue line, which faithfully traces the course of the forecasted values.

Table 2 . Year wise forecasted values

Year	Forecasted values
2023	23.84
2024	23.71
2025	23.59
2026	23.46
2027	23.34
2028	23.22
2029	23.09
2030	22.97
2031	22.84
2032	22.72

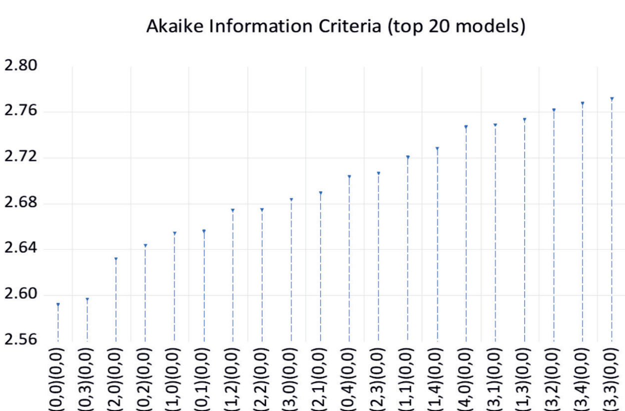

Figure 2 : Akaike information Criteria of different model

Table 3 . Information criteria comparison table

Model	LogL	AIC	BIC	HQ
(0,0)(0,0)	-36.87	2.59	2.68	2.62

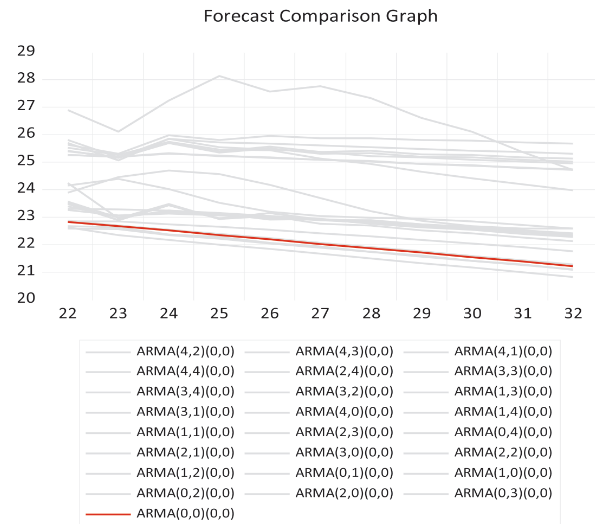

Figure 4 : Forecast comparison graph

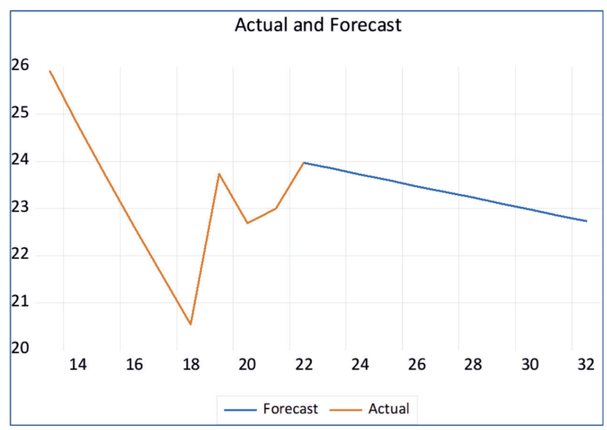

Figure 3 : Graphical representation of actual and forecasted values

As shown in Table 4, this holistic Granger causality analysis sheds light on the intricate relationships between crucial socioeconomic indicators and female labour force participation (FLFP). Our investigation commences with the enrollment in secondary education (female), revealing a significant p-value at the 5% level, firmly establishing that its Granger causes FLFP, signifying the pivotal role of female education in bolstering workforce engagement. Conversely, a unidirectional relationship is observed, where FLFP does not Granger cause enrollment in secondary education (female), underscoring the education-to-labour-force-participation causal direction. Shifting focus to fertility rate and infant mortality rate, our discerning analysis

Table 4: Result of Granger causality test

Null hypothesis	F statistic	p value
D(ENRL) does not Granger Cause D(FLFP)	4.39627	0.0242
D(FLFP) does not Granger Cause D(ENRL)	0.28122	0.7574
D(FERT) does not Granger Cause D(FLFP)	1.98292	0.1605
D(FLFP) does not Granger Cause D(FERT)	0.39938	0.6753
D(IM,2) does not Granger Cause D(FLFP)	0.64781	0.5329
D(FLFP) does not Granger Cause D(IM,2)	0.85773	0.4378
D(PGDP) does not Granger Cause D(FLFP)	1.73489	0.1987
D(FLFP) does not Granger Cause D(PGDP)	8.83356	0.0014

(Where D(FLFP) denotes first difference of Female labour force participation rate, D(PGDP) denotes first difference of per capita GDP, D(FERT) denotes first difference of fertility rate and D(IM,2) denotes the second difference of infant mortality rate).

uncovers bidirectional insignificance, denoting the absence of predictive relationships between these variables and FLFP, portraying the multifaceted determinants of female labour force participation. Turning to per capita GDP, a profound revelation emerges: it does not Granger cause FLFP, while conversely, FLFP does Granger cause per capita GDP due to the presence of a significant p-value. This finding underscores the pivotal role of FLFP in driving economic growth through mechanisms such as increased productivity, human capital accumulation, and economic empowerment. These results unveil the intricate, context-dependent nature of these relationships and their multifaceted implications for policy and further empirical exploration.

Conclusion and Policy Implications

The empirical findings from our analysis bring out how economic expansion has a profound impact on female labour force participation, highlighting the crucial roles that urbanization, agricultural mechanization, and income dynamics play. The apparent inverse U-shaped pattern, which is common in developing countries throughout their early phases of development, has been the mainstay of this analysis. The forecasted graph provides an exhaustive view of our predictions. Following that, when visualized in the graph, these anticipated figures unambiguously reveal a discernible declining pattern in female labour force participation over time. In this comprehensive Granger causality analysis, our study unveils intricate relationships between pivotal socioeconomic indicators and FLFP . The importance of female secondary education in promoting labour involvement is highlighted by the fact that female secondary enrolment appears as a substantial Granger causation of FLFP. On the other hand, this causal relationship is unidirectional, with education driving FLFP and no evidence of reciprocal causality. Furthermore, analysis shows that there are no significant bidirectional relationships between infant mortality and fertility rates. Intriguingly, per capita GDP does not Granger cause FLFP; instead, FLFP Granger causes per capita GDP, underpinned by a significant p-value. These insights provide helpful counsel for policymakers working to advance gender equality and sustainable development. As we navigate the ever-evolving landscape of labour markets and economies, continued investigation into these intricate relationships will be essential for informed decision-making and progress toward a more inclusive and prosperous future for all.

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