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The Long-Run Relationship Between Gender Disparity and India's Economic Growth: A VECM Analysis

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***Abstract**:* An attempt was made in this study to investigate the long-run relationship between gender disparity and economic growth in India by applying appropriate econometric models covering the period from 1990-1991 to 2022-2023. The results showed a significant difference in the Gender Development Index and the Gender Inequality Index across the states of India. The results of the Ordinary Least Squares regression show that gender inequality had a negative effect on economic growth. The estimated error correction terms had appropriate negative signs at the 5 per cent level of significance, which confirmed that there could be a long-run equilibrium association between the dependent and independent variables. The results of the Vector Error Correction Model showed that lagged coefficients of education and health expenditure by one year had a significant positive effect on economic growth, implying that budgetary allocations for education and healthcare led to a rise in economic growth. The decomposition results showed that the variance in Gross State Domestic Product Per capita Income was mostly explained by Gender Inequality Index, Labour Force Participation Rate and Female Schooling. The findings would be helpful for policymakers in reducing gender inequalities in all forms across the states.

Keywords: Economic growth, Gender Inequality, Impact, India, OLS, VECM

I. Introduction

Human development and economic growth were closely associated with the economic growth of nations. Gender equality was one of the fundamental human

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rights, and it contributed to the sustainable economic growth of each country in the world (Parmar, 2020). Generally, gender disparities were more common among developing countries when compared to developed countries in the world. Theoretical and empirical studies have been interchangeably using the terms 'gender inequality, gender disparity, and gender gaps,' all of which referred to differences between men and women in various aspects of life, like differences in education, health, employment, earnings, access to amenities, and resources. The effect of the gender gap on economic growth studies was discussed widely in economic literature.

India has been one of the fastest-growing countries, moving towards becoming a developed nation. Since its independence, the Government of India has implemented various development schemes via Five-Year Plans and economic reforms with the help of its state governments. Though, some evidence, like Gendering Human Development by the Ministry of Statistics and Programme Implementation, Government of India, showed that there were wide human disparities across the Indian states (Refer to Appendix A). The UNDP's Human Development Report (2021-22) indicated that India's HDI score was 0.644, ranking it 134th out of 191 countries. The World Economic Forum's Report (2023) indicated that India's Gender Gap Index score was 0.643 (64.3 per cent), ranking it 127th out of 146 countries.

Gender inequalities have been barricades to socio-economic growth (Klasen & Lamanna, 2009; Agenor & Canuto, 2015; Siva & Klasen, 2021). Human capital investments in education and healthcare had been the most powerful instruments for reducing gender inequality (Lussier & Fish, 2016). Public spending on education and health sectors directly raises individuals' productivity, individual capabilities, real earnings, and women's labour force participation, and these factors contribute to economic growth (Lucas, 1988; Bloom & Canning, 2003; Bloom et al., 2004; Schultz, 1961 & Becker, 1964). Adequate spending on education and health has stimulated economic growth (Barro & Lee, 2001). The rest of the paper was organized as follows: Section 2 presents the relevant literature. The sources of data and econometric methodology were described in Section 3. The estimated empirical results were explored in Section 4, and the final Section 5 provided the Conclusion.

II. Review of Literature

Numerous empirical studies **have examined** the impact of gender inequality on economic growth and also the causal association among economic growth, investments in education, and health in developing and developed countries. This study first briefly **reviewed** available Indian and international studies related to the impact of gender inequality on economic growth and studies related to the relationship between public human capital expenditure (education and health) and economic growth. The following studies, like Lutz & Mcgillivray (2009) **examined** the effect of gender inequality in education on 31 sub-Saharan African and Arabian countries' economic growth, covering the period from 1974 to 2004 using panel data analysis and the Generalized Method of Moments (GMM). Basumatary (2020) **investigated** the impact of gender inequality in education on economic development in India using the OLS model based on data from the Human Development Index for the year 2015 and the Gender Parity Index of the literacy rate for the year 2011 in different states of India. Klasen & Lamanna (2009) **investigated** the effects of the gender gap on economic growth via education and employment using the Panel Regression model in a cross-country analysis for the Middle East, North Africa, and South Asia during the period from 1960 to 2000. Mukherjee & Mukhopadhyay (2013) examined how gender inequality in education and labour force participation affected the economic growth of 61 developing countries in Africa, Asia, and Latin America during the year 2010. Baliamoune & McGillivray (2015) examined the impact of gender inequality in education on income from a group of sub-Saharan African, North African, and Middle Eastern countries using 1974 to 2001 panel data. Koengkan et al. (2022) analyzed the effect of gender inequality on the economic growth of 17 countries in the Latin American and Caribbean (LAC) regions during 1990 to 2016 using the Ordinary Least Square (OLS) model. These studies found that gender inequality had a significant negative effect on economic growth

The following studies, Tang and Lai (2011), examined the causal relationship between health and education expenditure in Malaysia from 1970 to 2007 using Granger and Yamamoto MWALD causality tests. Maitra & Mukhopadhyay (2012) examined the effect of public expenditure in education and healthcare on promoting the GDP in selected ASIAN and PACIFIC countries over the last three decades (1981-2011) using time series techniques. A few available Nigerian studies (Torruam & Abur, 2014; Adekola, 2014 & Ayuba, 2014) examined the relationship among public investment in education and health, and economic growth, applying the ADF test, Co-integration, and the Vector Error Correction Model. Wong & Yusoff (2015) examined the association between education and healthcare expenditures and Malaysian economic growth using the Granger Causality test over the period from 1980 to 2012.

Few Indian studies, like Sharma & Sahni (2015), examined the causality relationship between human capital investment and Indian economic growth during 1991-1992 to 2012-2013 using co-integration, the Granger causality test, and the Vector Error Correction Model (VECM). A latest study by Mariappan (2019) **investigated** the impact of public social expenditures on Indian economic growth using VECM, covering the period 1990-1991 to 2016-2017 in the high-income states of India. The findings of these studies **indicated** that governments' spending on education and healthcare positively **influenced** economic growth and that there **was** a long-run relationship among economic growth, education, and health expenditures.

Research Gap & Issues

The review of the literature showed that no study had ever attempted to analyse the long-run relationship between gender disparity and economic growth in the Indian context using the latest data sources with econometric techniques during the period 1990-1991 to 2022-2023. Therefore, this study filled this noticeable gap in the Indian gender literature. Evidence showed that there was a wide gender disparity across Indian states. Basic needs and economic equalities are fundamental human rights in an economy like India.

Objectives & Contribution of this Study

Considering the above research gap, an attempt was made in this study to understand the influence of gender inequality on economic growth using the Ordinary Least Square (OLS) Model in the first stage. In the second stage, the VECM was applied to measure the short-run and long-run effects of human capital expenditure on education and health, gender inequality indexes, and the female labour force participation rate on economic growth during the period from 1990-1991 to 2022-2023. This analysis contributed to the existing Indian literature. Such an empirical analysis may have been essential for economists and policymakers to remove gender and income inequalities across the Indian states.

3. Econometric Methodology

Source of Data

The required quantitative data, such as Gross State Domestic Product Per capita Income (GSDPCI), Gender Inequality Index (GII), Gender Development Index

(GDI), Labour Force Participation Rate (LFPR), Female Schooling (FSE), Female Earned Income (FEI), and Human Development Index (HDI), **were collected** for the years 2012 and 2018 from Gendering Human Development, Ministry of Statistics and Programme Implementation, GOI. The Expenditures on Education (EE) & Expenditures Health (EH) covering the period from 1990-1991 to 2022-2023 **were obtained** from State Finances: A Study of Budgets, RBI, for various years. The GDPPCI, GII, School Enrolment Ratio (SER), GDI, and FLPR for ages 15-24 **were collected** from the World Development Indicators.

Measurement of the Variables

The capital and revenue expenditures for education were combined and then were taken as total Expenditure on Education (EE). Similarly, the capital and revenue expenditures for health data were combined and then were taken as total Expenditure on Health (EH). In the OLS specification, GSDPPCI (in Indian Rupees) was used as an economic growth (dependent variable), and independent variables, namely the GII score, GDI score, LFPR percentage, FS (Female mean years of schooling), and FEI (in Indian Rupees), were used. In the VECM specification, GDPPCI was used as the dependent variable. To capture GDPPCI (economic growth), the following variables, namely the GII score, SER percentage, GDI score, FLPR percentage, EE, and EH (in Indian Rupees), were taken as independent variables. The dependent and independent variables were converted into natural logarithms.

Econometric Applications

To examine the effect of linear relationships between the dependent and independent variables for all states of India during 2018, the OLS model **was written** as

$$\ln GSDPPCI = \beta_0 + \beta_1 \ln GII + \beta_2 \ln GDI + \beta_3 \ln LFPR + \beta_4 \ln FSE + \beta_5 \ln FE + u_i \tag{1}$$

Unit root Test

The required data sets should have been stationary for a regression analysis. So, the first step was to check for the stationarity of the time series data, which would mostly have been non-stationary. In this study, the Null Hypothesis (H0): $\beta = 0$; Data were non-stationary (unit root) and it implied that the time series were integrated of order zero, I (0). The Alternative Hypothesis (H1): $\beta \neq 0$ Data were stationary (not unit root), stating that the series were integrated of order one I (1). The ADF could have been specified as follows

$$\Delta V_t = \alpha + \delta_t + \beta V_{t-1} + \sum_{i=1}^{k} (\gamma i \, \Delta V_{t-i}) + e_t \text{ (Model with constant\& Trend)} \quad (2)$$

Where, Δ denoted the first difference operator (V_t-V_{t-1}), Y denoted all the time series variables under consideration captured any time trend, k denoted the maximum lag length, α, β and γ were the parameters to be estimated, the error terms (e) were assumed to be normally distributed $(0, \sigma^2)$.

Co-integration Test

If all the variables used **had been** stationary at their level, the Johansen (1991) co-integration test **would have been** extensively used to verify whether the variables **were** co-integrated. If the variables **were** co-integrated, it **meant** that a long-run equilibrium association **existed** among the variables. The Trace statistic (λ-trace) and Maximum Eigenvalue statistic (λ-max) test statistics **were applied** to estimate the co-integration ranks, which **were** specified as

$$\lambda_{\text{Trace (r)}} = -T \sum_{i=r+1}^{k} \ln(1 - \hat{\lambda}) \quad (3)$$

$$\lambda_{\max}(r, r+1) = -T \ln(1 - \hat{\lambda}) \quad (4)$$

Where $\hat{\lambda}$ denoted Eigenvalues, T denoted the number of observations, and k denoted the number of endogenous variables. The Null Hypothesis (Ho) meant no co-integrating relation against the Alternative hypothesis between the time series variables.

VECM Framework

The co-integration test **showed** a long-run relationship between the variables, but it **did** not show the short-run dynamics relationship. Therefore, in the next step, VECM **was employed** to examine the presence of equilibrium in the short run and long run. The VECM for GDPPCI **was** specified as follows

$$\Delta GDPPCI_t = \alpha_1 + \delta_1 EC_{t-1} + \sum_{i=1}^{k} \gamma_{1i} \Delta GDPPCI_{t-1} + \sum_{i=1}^{k} \psi 1i \Delta GII_{t-1} + \sum_{i=1}^{k} \Phi_{1i} \Delta SER_{t-11} + \sum_{i=1}^{k} \lambda_{1i} \Delta GDI_{t-11} + \sum_{i=1}^{k} \omega_{1i} \Delta FLPR_{t-11} + \sum_{i=1}^{k} \theta_{1i} \Delta EE_{t-11} + \sum_{i=1}^{k} \pi_{1i} \Delta EH_{t-11} + u_t \quad (5)$$

Where, the time series of first difference were denoted by ΔGDPPCI, ΔSER, ΔGII, ΔGDI, Δ*EE* and Δ*EH*. $(EC)_{t-1}$ the error correction term lagged one period, and δ_1, δ_2, δ_3 were coefficients of the error corrections (speed of adjustment).

Granger Causality Test & Variance Decomposition Method

The VEC-Granger causality test **was applied** to determine the direction of causality among the variables, which **could have been** unidirectional (one-way) or bidirectional (two-way), or there **could have been** no relationship among the variables. Finally, the variance decomposition method **was** also used in this study to understand the dynamic effects (strength of variance) of specific shocks among the variables.

IV. EMPIRICAL RESULTS AND DISCUSSIONS

Results of OLS

The estimated results of OLS **were reported** in Table 1. The estimated coefficients of all variables **had** a statistically significant effect on economic growth. The coefficients of GII and FS **had** a negative impact on economic growth. The estimated results of OLS **suggested** that a 1 unit increase in the GII **led** to a decline in GSDPPCI on average by 0.312 units, holding other factors constant. Similarly, assuming other factors remained constant, a 1 unit decrease in FS **led** on average to about a 0.187 unit decrease in economic growth (GSDPPCI). This finding of a negative effect of FS on economic growth **was** inconsistent with the work of Hassan & Rafaz (2017). The results **suggested** that a 1 unit increase in GDI **led** to an increase on average by 0.089 units in GSDPPCI, holding other factors constant.

The results **suggested** that gender inequality **had** a negative effect on economic growth, and this **was** similar to the findings of Koengkan et al. (2022), which **indicated** that gender inequality negatively **affected** the GDPPCI using the OLS model. The estimated coefficients of LFPR and FEI **had** a positive impact on GSDPPCI. The results **suggested** that if there **was** a 1 unit increase in the LFPR, economic growth **was** expected to increase significantly on average by 0.457 units, holding other factors constant. Similarly, if FEI **increased** by 1 unit, on average, the GSDPPCI **increased** significantly by 0.826 units, assuming all other factors remained constant. The adjusted R^2 value **showed** that about 89 per cent of the variation in GSDPPCI **was explained** by the independent variables in the OLS model.

Table 1: Estimated Results of OLS model

Variable	*Dependent Variable: GSDPPCI*			
Independent Variables	*Coefficients*	*Standard Error*	*'t' Statistics*	*P-value*
Intercept	4.171984	0.616028	6.772388	0.0000
lnGII	-0.312492	0.11902	-2.62547	0.0135
lnGDI	0.089330	0.040052	2.23035	0.0334
lnLFPR	0.457011	0.081887	5.58097	0.0001
lnFS	-0.187100	0.260978	-0.71692	0.0790
lnFEI	0.826755	0.059688	13.85121	0.0000
Statistics				
R-Square 0.909 Adjusted R-Square 0.894				
Observation	36			

Source: Authors' estimation

Estimated Result of ADF Test

The results of the ADF unit root test **were reported** in Table 2. The results **indicated** that GDPPCI, GII, SER, GDI, FLPR, EE, and EH **were** non-stationary at their level but **were** stationary at their first-order difference at the 5 per cent level of significance.

Table 2: Estimated results of Augmented Dickey Fuller Unit Root Test

Variable	*At their level*			*Decision*	*At their first difference*			*Decision*
	Computed statistic	*Critical value @ 5 %*	*P-Value*	*Non-Stationary*	*Computed Statistic*	*Critical value @ 5 %*	*P-Value*	*Stationary*
GDPPCI	-1.764	-3.557	0.698	I (0)	-5.335	-3.562	0.0008	I (1)
GII	-0.851	-3.580	0.947	I (0)	-4.776	-3.580	0.0035	I (1)
SER	-0.301	-3.557	0.987	I (0)	-4.151	-3.562	0.0136	I (1)
GDI	-1.290	-3.557	0.872	I (0)	-5.257	-3.622	0.0017	I (1)
FLP	-0.159	-3.557	0.991	I (0)	-4.120	-3.562	0.0146	I (1)
EE	-2.007	-3.557	0.5752	I (0)	-5.886	-3.562	0.0002	I (1)
EH	-4.944	-3.587	0.202	I (0)	-4.536	-3.595	0.006	I (1)

Source: Authors' estimation

This meant that the non-stationary variables **were transformed** into stationary variables by taking the first difference, integrated of the same order I (1). The results **showed** that all computed statistics **were** greater than the critical value at the 5 per cent level of significance. Therefore, the Null Hypothesis **was rejected**.

Estimated Result of Johansen Co-integration Test

The results of the co-integration test **were presented** in Table 3. It **was** used to find the co-integrating equation after checking the Trace Statistic and Max Eigen Statistic at the 5 per cent level of significance. Both statistics at most from 1 to 5 levels **were** less than their respective critical values. So, we **could** not reject the Null hypothesis. It **implied** that all the variables included **were** not co-integrated (no long-run relationship). Therefore, in the next step, the impact of gender inequalities on economic growth **was** estimated via VECM.

Table 3: Estimated result of Johansen Co-integration test

Hypothesized No. of CE(s)	*Trace Statistic*	*Critical Value @ 5%*	*Prob. Value*	*Inference*
None *	133.0781	95.75366	0.0000	No co-integrated
At most 1	81.02817	69.81889	0.1049	co-integrated
At most 2	50.34444	47.85613	0.1286	co-integrated
At most 3	31.10650	29.79707	0.1351	co-integrated
At most 4	13.23815	15.49471	0.1064	co-integrated
At most 5	0.395019	3.841465	0.5297	co-integrated
Hypothesized No. of CE(s)	Max-Eigen Statistic	Critical Value @ 5%	Prob. Value	
None *	52.04996	40.07757	0.0014	No co-integrated
At most 1	30.68373	33.87687	0.1148	co-integrated
At most 2	19.23794	27.58434	0.3964	co-integrated
At most 3	17.86835	21.13162	0.1348	co-integrated
At most 4	12.84313	14.26460	0.1828	co-integrated
At most 5	0.395019	3.841465	0.5297	co-integrated

Source: Authors' estimation

Note: Trace test indicates 1 co-integrating equation (s) at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level

** MacKinnon-Haug-Michelis (1999) p-values

Estimated Result of VECM

Table 4 **indicated** that GII, GDI, and EH, each lagged by one period, **had** a significant effect on economic growth (GDPPCI) in specification (1). In specification (2), the results **suggested** that a 1 unit increase in D(GII(-1)), lagged by one period, **led** to a 2.51 unit decrease on average in GDPPCI, holding all other factors constant. Similarly, a 1 unit increase in D(GDI(-1)), lagged by one period, **led** to a 4.40 unit increase on average in GDPPCI, assuming all other factors remained constant. Likewise, the results **suggested** that a 1 unit decrease in D(FLPR(-1)), lagged by one period, **caused** GDPPCI to decrease on average by 5.47 units.

In specification (3), the results **showed** that FLPR and SER **were** the most important factors in explaining the variation in GDPPCI. Results **suggested** that a 1 unit increase in D(SER(-1)) in the previous year **led** to a 7.74 unit increase on average in GDPPCI, with other factors remaining constant. In specification (4), the results of lagged coefficients by one year for education and health expenditure **had** a significant positive effect on economic growth. It **showed** that budgetary allocations for education and healthcare **led** to a rise in economic growth. The results **suggested** that a 1 unit increase in D(EE(-1)) in the previous year **caused** GDPPCI to increase by 0.06 units. Likewise, a 1 unit increase in D(EH(-1)) in the previous year **increased** the GDPPCI by 0.083 units. This finding **was** not similar to the existing study by Ansari and Singh (1997) in India, but it **was** similar to the existing studies by Maitra & Mukhopadhyay (2012), Ayuba (2014), Sharma & Sahni (2015), and Mariappan (2019).

Table 4: Estimated Results of the VECMin India

Variables	*Dependent Variable: lnGDPPCI*			
	Specifications			
	(1)	*(2)*	*(3)*	*(4)*
Independent Variables	*Coefficient*	*Coefficient*	*Coefficient*	*Coefficient*
EC_{t-1}	-0.59671*	-0.86016*	-0.54332*	-0.01985*
	(5.06284)	(-4.8512)	(-6.6267)	(-0.9057)
D(lnGDPPCI(-1))	-0.026477	0.163931	0.00577	-0.013095
	(-0.17949)	(1.0842)	(0.03756)	(-0.06750)
D(lnGII(-1))	2.136143*	-2.51397**	0.85241	
	(2.29204)	(-2.51898)	(1.44608)	
D(lnSER (-1))	4.530990		7.74619**	
	(1.05521)		(2.07735)	
D(lnGDI(-1))	3.390712***	4.40159**		
	(1.76168)	(2.11587)		
D(lnFLPR(-1))	-20.78433	-5.47082**	-35.5545**	
	(-1.22150)	(-2.7770)	(-2.3934)	

Variables	*Dependent Variable: lnGDPPCI*			
	Specifications			
	(1)	*(2)*	*(3)*	*(4)*
D(lnEE(-1))	0.335910			0.06732*
	(2.50025)			(0.4253)
D(lnEH(-1))	0.466187**			0.0830**
	(2.85062)			(0.4763)
Constant	0.078893**	0.08575*	0.12747*	0.06357
	(3.63315)	(3.83461)	(5.85745)	(3.1192)
Statistics				
R-squared	0.575270	0.53715	0.65681	0.035780
Adj. R-squared	0.420823	0.39628	0.57101	0.112562
Observation	33	33	33	33

Source: Authors' estimation

Note: Figures in parentheses are't' values. (ii) *and ** indicate significant at 1 % and 5% levels respectively

The estimated error correction terms (speeds of adjustment) **had** appropriate negative signs at the 5 per cent level of significance. These terms **suggested** that the short-run disequilibrium **was** corrected every period by about 59.6, 86, 54.3, and 1.98 per cent towards the long-run equilibrium in specifications (1), (2), (3), and (4), respectively, which **confirmed** that there **could be** a long-run equilibrium association between the dependent and independent variables. The adjusted R^2 value **revealed** that the independent variables jointly **accounted** for approximately 42, 39, 57, and 11 per cent of the variation in the GDPPCI in specifications (1), (2), (3), and (4), respectively, while the remaining per cent of the variations **could have been** explained by other variables that **were** not included in the VECM.

Results of Causality Test

The estimated results of the VEC Granger Causality analysis were reported in Table 5. The testing of the Null Hypothesis was (H0): Granger non-causality (no causality between the dependent variable and independent variables).

Table 5: Estimated Results of the VEC Granger Causality Test

Equation (1) : Dependent variable (D(lnGDPPCI))				*Equation (2) : Dependent variable (D(lnGII))*			
Excluded	*Chi-Sq (χ^2)*	*P-value*	*Causality*	*Excluded*	*Chi-Sq (χ^2)*	*P-value*	*Causality*
D(lnGII)	5.253465	0.0219	Yes	D(lnGDPPCI)	0.693287	0.4050	No
D(lnSER)	1.113467	0.2913	No	D(lnSER)	1.125084	0.2888	No
D(lnGDI)	3.103530	0.0781	Yes	D(lnGDI)	2.935330	0.0867	Yes
D(lnFLPR)	1.492074	0.2219	No	D(lnFLPR)	0.541949	0.4616	No
D(lnEE)	6.251270	0.0124	Yes	D(lnEE)	0.617273	0.4321	No
D(lnEH)	8.126022	0.0044	Yes	D(lnEH)	0.438200	0.5080	No
All	14.44339	0.0251	Yes	All	16.60680	0.0108	Yes
Equation (3) :Dependent variable (D(lnSER))				*Equation (4) : Dependent variable (D(lnGDI))*			
Excluded	*Chi-Sq (χ^2)*	*P-value*	*Causality*	*Excluded*	*Chi-Sq (χ^2)*	*P-value*	*Causality*
D(LNGDPPCI)	0.982922	0.3215	No	D(lnGDPPCI)	0.742948	0.3887	No
D(lnGII)	0.868125	0.3515	No	D(lnGII)	0.148374	0.7001	No
D(lnGDI)	0.736458	0.3908	No	D(lnSER)	0.086455	0.7687	No
D(lnFLPR)	0.339808	0.5599	No	D(lnFLPR)	0.072326	0.7880	No
D(lnEE)	0.231683	0.6303	No	D(LNEE)	0.086457	0.7687	No
D(lnEH)	0.290016	0.5902	No	D(lnEH)	0.099943	0.7519	No
All	2.981682	0.8111	No	All	1.609170	0.9519	No
Equation (5) : Dependent variable(D(lnFLPR))				*Equation (6) : Dependent variable(D(lnEE))*			
Excluded	*Chi-Sq (χ^2)*	*P-value*	*Causality*	*Excluded*	*Chi-Sq (χ^2)*	*P-value*	*Causality*
D(lnGDPPCI)	0.846498	0.3575	No	D(lnGDPPCI)	2.517140	0.1126	No
D(lnGII)	0.779861	0.3772	No	D(lnGII)	0.322207	0.5703	No
D(lnSER)	0.577804	0.4472	No	D(lnSER)	4.437433	0.0352	Yes
D(lnGDI)	0.589934	0.4424	No	D(lnGDI)	0.080169	0.7771	No
D(lnEE)	0.121171	0.7278	No	D(lnFLPR)	3.635380	0.0566	yes
D(lnEH)	0.163643	0.6858	No	D(LNEH)	2.010033	0.1563	No
All	2.941526	0.8161	No	All	11.67627	0.0696	yes
Equation (7) : Dependent variable ((D(lnHE))							
Included	*D (lnGDPPCI)*	*D(lnGII)*	*D(lnSER)*	*D(lnGDI)*	*D(lnFLPR)*	*D(lnEE)*	*All*
χ^2	1.626278	0.285978	3.405284	0.001157	2.732742	1.633776	9.91785
P-value	0.2022	0.5928	0.0650	0.9729	0.0983	0.2012	0.1282
Causality	No	No	Yes	No	Yes	No	No

Source: Authors' estimation

The results of equation (1) showed that independent variables (GII, GDI, EE, and EH) significantly influenced the dependent variable (GDPPCI). This meant that there was a bidirectional causal relationship between the dependent and independent variables, so the null hypothesis was rejected. Equation (2) showed that only GDI Granger-caused GII, and only SER and FLPR Granger-caused EE in equation (6). However, the study found **unidirectional** causality from the independent variables

(GII, GDI, EE, and EH) to the dependent variable (GDPPCI) in equation (1), and bidirectional causality between GDI and GII (equation 2), and between SER, FLPR and EE (equation 6). Therefore, the finding confirmed that GII, GDI, EE, and EH played a crucial role in increasing GDPPCI.

Results of Variance Decomposition

The results of the variance decomposition of GDPPC based on VECM were reported in Table 6. The results for the five variables showed the variance decomposition of each variable over a decade. Results indicated that in the fifth year lag period, 55.3 per cent of the variance of GDPPCI was explained by 15.5 per cent of the variance of GII and 13 per cent of the variance of SER. In the tenth lag period, 49 per cent of the variance of GDPPCI was explained by 16 per cent of the variance of GII, 15 per cent of the variance of SER, and 9.6 per cent of the variance of FLPR. The study found that the variance of GDPPCI was mostly explained by GII, SER and EH. These variables played a significant role in influencing economic growth.

Table 6: Estimated Results of the Variance Decomposition Method

Period	*S.E.*	*lnGDPPCI*	*lnGII*	*lnSER*	*lnGDI*	*lnFLPR*	*lnEE*	*lnEH*
1	0.055827	100.0000	0.00000	0.00000	0.00000	0.00000	0.000000	0.000000
2	0.083699	81.27715	5.24450	0.19253	0.63461	1.87365	5.419252	5.358284
3	0.118940	67.73465	12.2304	4.00205	0.81497	5.77628	2.686439	6.755156
4	0.157422	57.46029	14.8261	11.2654	2.39714	5.50404	1.891075	6.655829
5	0.187480	55.30828	15.5458	12.7485	2.46664	6.45864	1.699499	5.772522
6	0.212867	53.26721	15.7258	13.1877	2.52881	7.61622	1.617621	6.056509
7	0.237544	51.70350	15.8341	14.1093	2.50119	8.41500	1.394055	6.042764
8	0.260159	50.57128	15.8242	14.8993	2.56424	8.80358	1.326132	6.011232
9	0.280325	49.99708	15.7884	15.2090	2.53637	9.25390	1.270103	5.945020
10	0.299127	49.43320	15.7506	15.4628	2.53056	9.61043	1.223511	5.988848

Source: Authors' estimation

V. CONCLUSION

This study examined the short-run and long-run relationship between gender disparity and economic growth of India over the period 1990-1991 to 2022-2023, applying the OLS and VECM approaches. The descriptive results indicated that there was a significant difference in GDI and GII scores across the Indian states during 2011-2012 and 2017–2018. The co-integration test showed that all the variables were co-integrated or had a long-run relationship among them. The estimated results of VECM showed that GII, GDI, EE, and EH were the most important factors in influencing the variation of economic growth.

The results of VECM showed that the coefficients of error correction terms had significant and appropriate negative signs, and these terms indicated that the short-run disequilibrium was corrected by about 50 to 86 per cent each period towards the long-run equilibrium. The Granger-causality test indicated a bidirectional causality between independent variables (GII, GDI, EE, and EH) and the dependent variable (GDPPCI). The decomposition results showed that the variance in GDPPCI was mostly explained by GII, and FSE, and these variables played a major role in the variation of GDPPCI. The results advised giving more attention to reducing gender inequalities to achieve considerable economic growth across the Indian states, and it was also essential to increase budget allocation for the education and health sectors. The study's empirical findings would be helpful to policymakers in formulating strategies to reduce gender inequalities in all forms across Indian states.

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Appendix A: HDI, GDI and GII inequalities across the states during 2011-12 & 2017-18

Category	*HDI Score*	*2011-2012*	*2017-2018*
Very High	0.800 & above	DL	CG, DL and GA
High	0.700 to 0.799	CG, GA, HP, KL, MH, PY and TN	AN, HR, HP, KA, KL, MH, ML, MZ, PY, PB, SK, TN, TG and UK
Medium	0.550 to 0.699	AN, AP, AR, AS, CG, DH, DD, GJ, HR, J&K, JH, KA, LD, MP, MN, ML, MZ, NL, OR, PB, RJ SK, TG, TR, UP, UK and WB	AP, AR, AS, BR, CG, DH, DD, GJ, J&K, JH, LD, MP, MN, NL, OR, RJ, TR, UP and WB
Low	Below 0.550	BR	-
Category	GDI Scores		
Very High	Less or equal to 2.5 %	-	CG, HP, MZ, GA and SK
High	2.5 – 5 %	-	AN, KL and ML
Medium	5 - 7.5%	ML and SK	DD, DL, J&K, LD and PB
Low	7.5 and above	AN, CG, HP, AP, AR, AS, BR, CG, Dadra & N. Haveli , DD, DL, GA, GJ, HR, J&K, JH, KA, KL, LD, MP, MH, MN, MZ, NL, OR, PY, PB, RJ, TN, TG, TR, UP, U and WB	AP, DH, GJ, HR, MH, RJ, TN, UK, AR, AS, BR, CG, JH, KA, MP, MN, NL, OR, PY, TG, TR, UP and WB
Category	GII Score		
Very High	0.6 and above	AS, BR, J & K, JH, AN, AR, CG, DH, DD, GA, LD, MN, MZ, NL, PY and SK	BR, AN, AR, DH, DD, JH, LD, MN, MZ, NL and SK
High	0.500 to 0.599	DL, HR, KA, MP, OR, RJ, TR, UP, UK and WB	AS, RJ, TR, GA, PY, and UP
Medium	0.400 to 0.499	AP, CH, GJ, KL, MH, ML, TN and TG	CG, CH, DL, GJ, HR, KA, KL, MP, ML, OR, PB, TG, UK and WB
Low	Below 0.400	HP, PB	AP, HP, J & K, MH and TN
India	GII	GDI	HDI
2005	0.629	0.764	0.491
2010	0.612	0.785	0.575
2015	0.551	0.817	0.629
2022	0.437	0.852	0.644

Source: Authors' estimation using Human Development Index (HDI) 2012 & 2018, Ministry of Statistics and Programme Implementation, and UNDP' Human Development Report (2021-22) Reports