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Does female human capital contribute to economic growth in India?: an empirical investigation

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Abstract

Purpose – The purpose of this paper is to examine the impact of female human capital on economic growth in the Indian economy during 1970-2014.

Design/methodology/approach – The paper employs Ng-Perron unit root test to check the order of integration of the variables. The study also used ARDL-bounds testing approach and the unrestricted error-correction model to investigate co-integration in the long run and short run; Granger's causality test to investigate the direction of the causality; and variance decomposition test to capture the influence of each variable on economic growth.

Findings – The study constructed a composite index for both male and female human capitals by taking education and health as a proxy for human capital. The empirical findings reveal that female human capital is significant and positively related to economic growth in both short run and long run, while male human capital is positive but insignificant to the economic growth; same is the case for physical capital, it implies that such investment regarding female human capital needs to be reinforced. Further, there is an evidence of a long-run causal relationship from female human capital, male human capital and physical capital to economic growth variable. The results of variance decomposition show the importance of the female human capital variable is increasing over the time and it exerts the largest influence in change in economic growth.

Research limitations/implications – The empirical findings suggest that the Indian economy has to pay attention equally on the development of female human capital for short-run as well as long-run growth of the economy. This implies that the policy makers should divert more expenditure for developing support for female education and health.

Originality/value – To the best of authors' knowledge, this is the first attempt to study the relationship between female human capital and economic growth in the context of the Indian economy.

Keywords ARDL, Economic growth, Female human capital, Male human capital

Paper type Research paper

1. Introduction

Economic theory suggests that human capital is an important determinant of economic growth. Empirical evidence from a group of countries confirms this linkage. A country that starts with higher level of education attainment grew faster, given the initial per capita GDP. The channel of effect involves the positive effect on fertility and additional positive impact on growth given values of investment and fertility (Barro, 1991).

Following the work of Barro (1991), hundreds of separate researchers examined the question of what factors determined the differences in growth rates around the world. Numerous empirical studies have been conducted to establish the relationship between human capital and economic growth. Researchers have also found inherent inter-relationship between physical capital and human capital. Accumulating physical capital through human capital is more useful and productive for poor countries because effective use of physical capital is possible only with skilled and trained manpower. If there is underinvestment in human capital, then there will be under or limited utilization of physical capital (Lucas, 1988).

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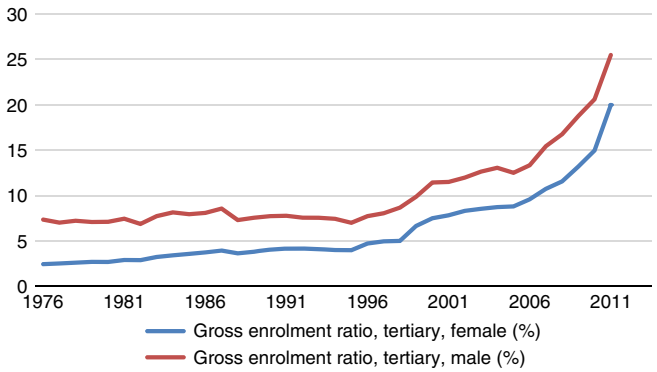
Lucas (1988) also suggested that poor countries are facing the problem of shortage in physical capital due to inadequate resources of human capital. Barro and Lee (1996) have extended the measure of human capital by including both education and life expectancy as the proxy of human capital. They have also contributed in gender separate human capital by taking primary and secondary education as a proxy and its effect on economic growth.

Human capital is defined as skills, knowledge and experience possessed by an individual and population viewed in terms of their values or costs to an organization or country. Economists are trying to measure school enrollment as a proxy of human capital. Regardless of precise modeling and proxies adopted, there is strong evidence that the higher the education level is, the higher the level of economic growth. After surveying a wide range of mode specification, Sianesi and Van Reensen (2002) concluded that a 1 percent increase in school enrollment leads to an increase in per capita GDP of between 1 and 3 percent. An additional year of secondary schooling will lead to more than 1 percent increase in economic growth each year.

The conventional thought of development economics is that an investment on female education and health in developing economies is more rewarding than the investment on men (Knowels *et al.*, 2002). The upliftment of female population not only promotes economic growth but also results in societal development of the economy. In this regard, the Millennium Development Goals (MDGs) stressed gender equality. Removal of such gender inequality will empower women socially and economically. Further, it will also help in poverty reduction, enhance human well-being and create sustainable development. There is common consensus that gender inequality is quite invisible in developing countries and is considered as one of the major obstacle in their economic growth (Morrison *et al.*, 2007).

Indian economy is subject to gender inequality and women suffer from unequal opportunities in health, education, nutrition and in control over productive resources. All these disparities prohibit women to reach the optimum level of productivity. So, the empowerment of women in India is very important to provide parallel opportunities regarding health, education, acquiring skills and employment (Figure 1).

India's socio-economic performance has never been very commendable since its independence in 1947. In 1960s, comparatively overall economic performance was better compared to the preceding decade. However, after 1965 war with Pakistan, the spending on education and health has been declined. The social sector regained its importance after the implementation of India's education commission report in 1966 and functioning of NCERT. The social sector in India is still the most neglected sector compared to many developing countries. India's overall public expenditure on education is around 3.1 percent of GDP and public expenditure on health is around 1.2 percent of GDP. According to Human



Source: World Bank

Figure 1.
Trend in the Gross enrolment ratio, tertiary (male vs female)

Development Index, which is three-dimensional measures of basic achievements in health, education and living standard, India is ranked 135 out of 186 countries in 2012. At the same time the Gender Development Index (GDI) measures gender gap in human development achievements in three basic dimensions of human development: health, measured by female and male life expectancy at birth; education, measured by female and male expected years of schooling for children and female and male mean years of schooling for adults ages 25 and older; and command over economic resources, measured by female and male estimated earned income.

With respect to GDI ranking, India is ranked 132 out of 146 countries. It is noted that Bangladesh ranked 107 and Pakistan ranked 145 in the world ranking (UNDP, 2013). As per Gender Inequality Index (GII), which reflects three inequalities such as, reproductive health, empowerment and economic activity, India ranked 132 out of 146 countries. Bangladesh ranked 111 and Pakistan ranked 123 in the world ranking according to UNDP report in 2013. This shows that women in India are far behind men in acquiring empowerment, economic activity and labor participation compared to many developing economies in the world.

Tables I and II present the adult literacy rates and mortality rates in India. Examining the pattern and trend of the rates, it is observed that the adult literacy rate for female was half of that for male counterparts in 1980s. However, there were drastic improvements in the rates by 2011. The gap between male literacy rates and female literacy rates are reduced dramatically. Similarly, the female mortality rates were around 96.1 per 1,000 births in 2000 which reduced to 49.2 per 1,000 births by 2015. This improvement in education and health situations can partly be attributed to the sustained and cautious policy measures undertaken by the state and the central governments since the early 2000s. Various measures taken periodically were aimed at reducing the health hazards and improving literacy by increasing developmental government expenditures.

In retrospect, keeping in view the above situation and the importance of such measures exhibited by the Indian economy during last two decades, this study therefore proposes to examine the impact of female human capital on economic growth in the Indian economy during 1970-2014. To the best of authors' knowledge, our work is the first attempt to study the relationship between female human capital and economic growth in the context of the Indian economy by using modern econometric techniques. Hence, our work is different from the existing work and has significant contribution to the existing literature.

Indicator	1981	1991	2001	2011
Adult literacy rate, population 15+ years, female (%)	25.67	33.72	47.84	59.27
Adult literacy rate, population 15+ years, male (%)	54.84	61.64	73.41	78.87
Adult literacy rate, population 15+ years, both sexes (%)	40.76	48.22	61.01	69.30

Source: World Bank

Table I.
Adult literacy rates in India

Year	Mortality rate, under 5 (per 1,000)	Mortality rate, under 5, female (per 1,000 live births)	Mortality rate, under 5, male (per 1,000 live births)
2000	91.2	96.1	86.6
2010	59.9	62.9	57
2015	47.7	49.2	46.3

Source: World Bank

Table II.
Mortality rates in India

This study is divided into five sections including the introduction. Section 2 presents the literature review. Section 3 provides data, model construction and econometric methodology is discussed in Section 4. Section 5 discusses the empirical results while Section 6 concludes the paper.

2. Literature review

The contribution of human capital as a source of economic development has long been an issue of interest among the academicians. The importance of human capital for economic growth has been a topic of intense discussion during last two decades. It includes studies from neoclassical exogenous growth models of Solow (1956) and Swan (1956) to endogenous growth model of Romer (1994) to empirical evidence-based studies with modern econometric techniques.

In the literature, many empirical studies have favored a strong and positive relationship between human capital and economic growth. However, this relationship based on the choice of proxy remained ambiguous. The seminal work of Lucas (1988) focused on the significance of human capital accumulation as a source of economic growth. Lucas observed that the accumulation of human capital is the main driver of economic growth.

The study of 96 countries by Benavot (1989) during the period 1960-1985 stated that the primary enrollment rates of both females and males have strong positive effects on economic growth and that these effects weaken only slightly when fertility and labor force measures are included. By using GMM estimation for 93 non-oil countries over the time frame 1960-1985, Caselli *et al.* (1996) found a positive coefficient of female education and a significantly negative coefficient of male education. Birdsall *et al.* (1997) reported that the impact of both male and female education is same in stimulating economic growth for 108 developed and developing countries during 1960-1985.

Hill and King (1993) revealed that both the level of female education and the gap between the levels of male and female education are significant determinants of economic growth. In a study of 100 countries, Dollar and Gatti (1999) found that the gender-specific gap in education disappears with development, while efforts to educate girls boost the pace of development and in turn promote education. The study also revealed that 1 percent increase in the share of women with secondary education increases economic growth by 0.3 percent. The results stated that more developed economies have negative and not significant coefficient for male secondary education, while positive and significant coefficient has been estimated for female education. Lorgelly (1999) employed 2SLS estimation for the period 1960-1990 for 72 developed and developing economies and they concluded that female education and female life expectancy (as well as aggregate life expectancy) have a positive effect on economic growth, while the impact of male human capital was not clear in the study. Further, a study by Durham (1999) found that the female education rate is negative and proxy for male education rates is positive, while both human capital measures are insignificant.

Psacharopoulos and Patrinos (2002) supported the benefits of female education. The empirical findings of the study have concluded positive returns to education, while female education returns relatively higher than male. Klasen (2002) examined the relationship between gender inequality in education and long-term economic growth during the period 1960-1992 by using cross-country and panel regressions. The empirical findings suggest that gender inequality in education directly affects economic growth by lowering the average level of human capital. Self and Grabowski (2004) took the case of the Indian economy and examined the impact of education on income growth over the time period 1966-1996. The empirical findings suggested that female education has significant potential in economic growth.

Zaman (2010) tried to explore the causal relationship between female enrollment rates and economic growth in Pakistan during the period 1966-2008 by using co-integration and

Granger causality test. The empirical findings of the study support the unidirectional causality relationship between the economic growth and female enrollment. The studies of Cooray and Pervaiz *et al.* (2011) concluded that the gender discrimination and an inequality have an impact on the growth of an economy of Pakistan. The used variables are composite GII including educational index, labor participation index and survival index by assigning equal weighting to all three indexes. The results suggest that labor force growth, investment and trade openness have statistically significant and positive impact whereas gender inequality has a significant and negative effect on economic growth.

Cooray and Mallick (2011) supports the results of Barro (2001) which implies that the female human capital stock is associated negatively to the economic growth. The study also suggested that it has imperative for South Asia to promote the skill levels and education opportunities for females, in order to achieve high economic growth. Kaur and Letic (2012) examined the effect of female education on economic growth through human capital and fertility rate. They used two counties (India and Niger) to illustrate the effect. They concluded that female education does affect economic growth, through human capital and fertility rate.

Rehman *et al.* (2012) examined the contribution of human capital in economic growth of Pakistan during the time period 1974-2009. The study used health and education index as proxies for human capital. The empirical results suggest evidence of positive relationship between human capital and economic growth. The study also recommended more spending on human capital to attain a sustained economic growth in the economy.

Dauda (2013) examined the contribution of female education on economic performance in Nigeria for the period 1975-2008 by employing the co-integration and error-correction techniques. The findings reveled that the male education has a significant and positive impact on the Nigerian economy, while female education was not found significant. Cooray *et al.* (2014) investigated the role of gender-specific human capital on economic growth for south Asian economies over the time period 1970-2008. By employing an extended version of the Solow growth model, the study suggests that the human capital stock disaggregated by gender has differential impacts on economic growth during the study period in South Asia. Khan (2016) used the time series data for Pakistan to examine the contribution of female human capital in economic growth over the time period 1972-2012. The study concluded that female human capital has a positive and significant relationship with economic growth.

3. Data, variables and model construction

3.1 Data and variables

To conduct our empirical analysis and investigate the relationship between female human capital and economic growth, we have considered following variables for the Indian economy:

- per capita real GDP (PGDP) measured at 2005 constant US dollars which is used as the proxy for economic growth;
- gross fixed capital formation (GFCF) is measured as 2005 constant US dollar which is used as the proxy for physical capital; and
- the female human capital and male human capital are composite averages of education index and health index (see the Appendix).

The data are collected from World Bank Development Indicator, Economic survey of India and Reserve Bank of India. Our data are annual and cover the period of 1970-2014 for the Indian economy. The choice of data set is based on the availability of data for the used variables.

3.2 Model specification

The focus of the present study is to explore the contribution of female human capital on economic growth in Indian economy during 1970-2014. Growth model is created with segregated human capital (male and female) as explanatory variables. The female human capital and male human capital are composite averages of education index and health index. In order to explore the long-run relationship between female human capital and economic growth in India, the following linear logarithmic form is proposed:

$$\text{LPGDP} = \alpha_0 + \alpha_1 \text{LFC} + \alpha_2 \text{LMC} + \alpha_3 \text{LPHY} + \varepsilon_t \quad (1)$$

where PGDP is per capita real GDP; FC, the female human capital; MC, the male human capital; PHY, the physical capital; and ε is the random error term. The parameters α_1 α_2 α_3 α_4 and α_5 represent long-run elasticity of carbon dioxide emissions with respect to FC, MC and PHY, respectively.

4. Econometric methodology

The Ng and Perron (2001) unit root test is employed to check the stationarity properties of the series. This test does not suffer from severe size distributions properties when error term has negative moving-average root unlike other traditional unit root test (ADF, DF, PP and KPSS). Ng-Perron (2001) test employs the GLS de-trended data which are based on modified SIC/AIC.

4.1 Autoregressive distributed lag (ARDL) bounds test

The study employs the ARDL-bounds test proposed by Pesaran *et al.* (2001) to examine the co-integration relationship between female human capital and economic growth of respective sectors. The main advantage of ARDL modeling lies in its flexibility. This method is applicable irrespective of whether the underlying variables are I (1), I (0) or mixture of both. It avoids the pre-testing problems associated with standard co-integration techniques and also takes care of endogeneity. For small sample size, the ARDL model is also statistically more significant approach to determine the co-integrating relation.

The ARDL bound testing approach involves estimating the unconditional error-correction version (UECM) of the ARDL model which is modeled as follows:

$$\Delta \ln Y_t = \delta_0 + \delta_1 T + \delta_2 \ln X1_{t-1} + \delta_3 \ln X2_{t-1} + \delta_4 \ln X3_{t-1} + \delta_5 \ln X4_{t-1} + \delta_6 \ln X5_{t-1} + \sum_{i=1}^{q} \alpha_i \Delta \ln Y_{t-i} + \sum_{i=1}^{q} \beta_i \Delta \ln X1_{t-i} + \sum_{i=1}^{q} \mu_i \Delta \ln X2_{t-i} + \sum_{i=1}^{q} \sigma_i \Delta \ln X3_{t-i} + \varepsilon_t \quad (2)$$

where Δ is the difference operator, Y represents the independent variable, Xs are dependent variables, ε_t is white noise error term and T is time trend and ln implies that the variables have been transformed in natural logs.

There are two steps in testing the co-integration relationship between economic growth and the explanatory variables. First, we estimate Equation (1) by ordinary least squares technique. Second, the presence of co-integration is traced by restricting all estimated coefficients of lagged-level variables equal to zero. Therefore, the null hypothesis of no co-integration H_0:$\delta_2 = \delta_3 = \delta_4 = \delta_5 = \delta_6 = 0$ and the alternative hypothesis H_1: $\delta_2 \neq \delta_3 \neq \delta_4 \neq \delta_5 \neq \delta_6 \neq 0$ implies co-integration among the series.

If the computed F-statistic is less than the lower bound critical value, then we do not reject the null hypothesis of no integration. However, if the computed F-statistics is greater

than upper bound critical value, then we reject the null hypothesis of no co-integration. However, if the computed value falls within lower and upper bound critical values, then the result is inclusive.

Once the co-integration is established the conditional ARDL long run model for Y_t can be estimated as:

$$\Delta \ln Y_t = \alpha_0 + \sum_{i=1}^{q} \delta_1 \ln Y_{t-i} + \sum_{i=1}^{q} \delta_2 \ln X1_{t-i} + \sum_{i=1}^{q} \delta_2 \ln X2_{t-i} + \sum_{i=1}^{q} \delta_3 \ln X3_{t-i} + \varepsilon_t \tag{3}$$

where all variables are as previously defined. This involves selecting the orders of ARDL (q, q_1, q_2, q_3, q_4) models using SIC. The third and final step, we obtain the short-run dynamic parameters by estimating an error-correction model (ECM) with the long-run estimates. This is specified as below:

$$\Delta \ln Y_t = \mu + \sum_{i=1}^{q} \alpha_i \Delta \ln Y_{t-i} + \sum_{i=1}^{q_1} \beta_i \Delta \ln X1_{t-i} + \sum_{i=1}^{q_2} \mu_i \Delta \ln X2_{t-i} + \sum_{i=1}^{q_3} \sigma_i \Delta \ln X3_{t-i} + \phi \mathrm{ECM}_{t-1} + \varepsilon_t \tag{4}$$

where $\alpha, \beta, \mu, \sigma, \omega, \gamma$ are the short-run dynamic coefficients to equilibrium and ϕ is the speed adjustment coefficient. The ECM term is added in Equation (4) and above to test the significance of short-run and long-run relationship among variables in the model.

The error-correction term with lag value need to be significant to confirm the long run co-intergrating relationship and the coefficient (ϕi) of the error correction term ECM_{t-1} indicates the speed of adjustment back to long-run equilibrium after a short-run shock. To ascertain the goodness of fit of the ARDL model, diagnostic and stability tests are conducted. The diagnostic test examines the serial correlation, functional form, normality and heteroscedasticity associated with the model. The structural stability test is conducted by employing the cumulative sums (CUSUM) residuals and the cumulative sum of squares of recursive residuals (CUSUMSQ).

4.2 Granger causality test

The co-integration relationship indicates the existence of causal relationship between variables but it does not indicate the direction of causal relationship between variables. Therefore, we conduct the Granger causality test in the vector error corrective model framework (VECM) to examine the causality relationship between the stock market development and economic growth. The VECM regresses the changes in the variables (both dependent and independent variables) on lagged deviations and in general can be express by the following equation:

$$\Delta Z_t = \Pi Z_{t-1} + \Gamma_1 \Delta Z_{t-1} + \Gamma_2 \Delta Z_{t-2} + \cdots + \Gamma_{p-1} \Delta Z_{t-p+1} + e_t \tag{5}$$

where:

$$\Delta Z_t = [\Delta \Gamma Y, \Delta X1, \Delta X2, \Delta X3]' \tag{6}$$

$$\Pi = -\left(1_m - \sum_{i=1}^{p} A_i\right) \tag{7}$$

and:

$$\Gamma_i = -\left(1 - \sum_{j=1}^{i} A_j\right) \tag{8}$$

For $i = 1, \ldots, p-1$.Γ measures the short-run effect of the changes in Z_t. Meanwhile, the (4×4) matrix of $\prod = (\alpha\beta')$ contains both speed of adjustment to equilibrium (α) and the long-run information (β) such that the term βZ_{t-k} represents the $(n-1)$ co-integrating vector on the multivariate model. A test statistic is calculated by taking the sum of the squared F-statistics of Γ_i and t-statistic of $\prod$. The Granger causality is implemented by calculating the F-statistics (Wald test) based on the null hypothesis that the set of coefficients (Γ_i) on the lagged values of independent are not statistically different from zero. If the null hypothesis is accepted, then it can be concluded that the independent variables do not cause the dependent variables. On the other hand, if $\prod$ is significant (i.e. different from zero) based on the t-statistics, then both the independent and dependent variables have a stable relationship in the long run.

5. The empirical results and analysis

5.1 Unit root tests

In this subsection, the stationarity properties of the variables are studied. The Ng-Perron unit root test is utilized for the same. The results are provided in Table III, the results indicate that all series are non-stationary at their level but stationary at their first differences irrespective of using the random walk model with drift or random walk model with slope.

5.2 Co-integration test results

After determining the order of integration, next we employ ARDL approach to co-integration in order to determine the long run relationship among the variables. The F-statistics tests the joint null hypothesis that the coefficients of lagged-level variables in Equation (2) are zero. Table IV

Variables	MZa	MZt	MSB	MPT
LFC	1.4800	1.6886	1.1409	6.9661
LMC	−0.0601	−0.0328	0.5458	1.1929
LPGDP	−0.8805	−0.4223	0.4796	5.3017
LPHY	0.4769	0.3884	0.8145	0.6734
ΔLFC	−20.4722	−3.1979	0.1562	1.2018
ΔLMC	−19.4669	−2.9982	0.1814	1.5845
ΔLPGDP	−16.8125	−3.7689	0.2596	3.8596
ΔLPHY	−20.0893	−3.0854	0.1535	1.5128

Note: L denotes the natural logarithm of the variable and Δdenotes the first difference of the series

Table III.
Stationarity test of the variables: Ng-Perron (2001) unit root test

Panel I: bounds testing to co-integration	
Estimated equation: LPGDP = F (LFC, LMC, LPHY)	
Indicators	
Optimal lag	0.1
F-statistics	7.0041
Panel II: ARDL model diagnostic tests	
Diagnostic tests indicators	
Normality J-B value	0.0954 (0.2540)
Serial correlation LM test	0.2201 (0.6614)
Heteroscedasticity test (ARCH)	0.8143 (0.5510)
Ramsey RESET test	1.0041 (0.6020)

Note: Values in the parentheses are probability values

Table IV.
ARDL-bounds test

reports the result of the calculated *F*-statistics. The bounds test evidence confirms the long-run relationship between economic growth, physical capital, female and human capital in the Indian context as the calculated *F*-statistics greater than the critical values of the upper level of the bound at 5 percent level of significance. The results support the findings of Khan (2016). The estimated model also passes all the diagnostic tests.

The lag length of the unrestricted vector autoregressive model is determined on the basis of AIC and SBIC criteria and the adjusted likelihood ratio test is most commonly used. The test results of long-run and short-run estimates of ARDL are reported in Tables III and IV.

The empirical results of Table V suggest that female human capital is statistically significant and has positively impact on economic growth. The estimated coefficient is significant at 1 percent level of significance; this implies that female human capital contributes to economic growth in the Indian economy. However, the male human capital and physical capital variable is statistically insignificant but has a positive impact on economic growth.

The diagnostic test for serial correlation, hetereoscedasticity, functional misspecification and non-normal errors are conducted. The rest results indicate that there is no evidence of serial correlation, hetereoscedasticity, functional misspecification and non-normal errors. This implies that the errors are normally distributed and homoscedastic. The Ramsey RESET test confirms a well-specified model.

The short-run estimates of selected ARDL model are presented in Table VI. It is found that female human capital contributes in the short run as well. The coefficient of female human capital is positive and significant at 10 percent significance level.

The results of short-run dynamics using the ECM version of ARDL are reported in Table VI. The short-run results are not much different from the long-run estimates. The coefficient of the error correction term is an adjustment coefficient capturing the proportion of the disequilibrium in economic growth in one period which is corrected in the next period. The larger the error term, the faster the economy return to the equilibrium rate of growth following a shock. The estimated error correction term is −0.1892 and significant at 1 percent level. This indicates that following a shock, there is relatively slow return to the equilibrium growth in the following year. This implies the speed of adjustment of the model to equilibrium in the event of external shocks shows 18.92 percent of disequilibrium errors are corrected in a year and it takes more than five years to correct the deviation from disequilibrium. In addition, the significant error correction term further confirms the existence of a stable long-run relationship.

Table V.
Economic growth and female human capital – results of ARDL long-run model

(Dependent variable: LPGDP)			
Regressor	Coefficient	*t*-values	Prob. values
LFC	3.1605***	(2.0764)	0.0001
LMC	1.9768	(1.0076)	0.5540
LPHY	0.0769	(0.6682)	0.3255
CONS	0.1924	(0.2111)	0.8340
Robustness indicators			
R^2	0.99778		
Adjusted R^2	0.99740		
F-Statistics	2,625.7		
DW stat	2.6603		
Serial correlation	$F = 0.33961$	(0.653)	
Heteroskedasticity	$F = 0.51471$	(0.301)	
Ramsey RESET test	$F = 0.14120$	(0.741)	

Notes: Figures in parentheses are estimated *t*-values. ***Denotes 1 percent significance level

(Dependent variable: ΔLPGDP)			
Regressor	Coefficient	*t*-ratio	Prob. values
ΔLFC	0.5046*	2.0014	0.1100
ΔLMC	0.7455	0.9658	0.6692
ΔLPHY	0.0107	1.0125	0.8560
ΔCONS	0.1924*	2.0852	0.1021
ECM *t*−1	−0.1892	−2.8233	0.0081
Robustness indicators			
R^2	0.8211		
DW stat	1.9082		
SE regression	0.00822		
RSS	0.00869		

Notes: RSS, LL and DW are residual sum of squares, log likelihood and Durbin Watson, respectively. Figures in parentheses are estimated *t*-values. *Denotes 10 percent significance level

Table VI.
Economic growth and female human capital – results of ARDL short run model

5.3 Causality test based on ECM

Even though co-integration indicates the presence of Granger causality, at least in one direction, it does not indicate the direction of causal linkage among the used variables in the model. This study explores the direction of the Granger causality through the ECM derived from the long-run co-integrating vectors. Table VII explores the short-run and long-run Granger causality within the error correction mechanism. The empirical results indicate that in the case of short run, there exists a unidirectional causality between female human capital and male human capital with economic growth. This implies that any improvement in female human capital and male human capital causes economic growth in India. In the long run, there is an evidence of a long-run causal relationship from female human capital, male human capital and physical capital to economic growth variable.

5.4 Variance decomposition analysis

In order to compare the contribution extents of female human capital, male human capital and physical capital to the change of economic growth in the Indian economy over the study period (1970-2013), the variance decomposition approach is adopted.

The results of variance decomposition analysis can be seen in Table VIII. By implementing the variance decomposition test, we found that 6.75 percent economic growth is explained by its own innovative shocks, 61.94 percent by female human capital, and 28.67 percent by male human capital and by 2.62 percent physical capital in the tenth period. Therefore, female human capital acts as a major driver of economic growth.

		Sources of causation			
		Short-run (or weak)			Long run
Dependent Variable	ΔLPGDP	ΔLFC	ΔLMC	ΔLPHY	ECT (*t*-value)
ΔLPGDP	–	2.0014**	0.9928	1.9822**	−2.7210**
ΔLFC	0.6214	–	0.9632	1.5014	−1.0041
ΔLMC	0.0814	1.0417	–	0.2240	−0.9521
ΔLPHY	0.8855	0.8141	0.5814	–	−0.6921

Notes: Δ is the first difference operator. The number of appropriate lag is one according to Akaike information criterion and Schwarz information criterion and Hannan-Quinn information criterion. **Denotes 5 percent significance level

Table VII.
Granger causality test

5.5 Stability test

The CUSUM and the CUSUMSQ tests are employed to check the stability of the long-and short-term parameters. It is observed that the plots of the graph (Figure 2) for both the tests lie within 5 percent critical bounds, which imply that the estimated model is stable and correctly specified and there is no systematic change identified in the coefficient over the sample period at 5 percent significance level (Figure 3).

6. Conclusion and policy implications

India is a developing economy and its economic growth has been low and inconsistent before liberalization in 1991. During the period, female segment has been denied fair access to social and economic opportunities. They have been deprived of acquiring education, skill and equal opportunities compared to the male counterparts. India's gender inequality indices show greater gender discrimination with respect to health, education and economic opportunities. This situation is worse in the rural areas even today. In India, public policies with respect to female education and health have not been successful after liberalization due to poor planning, bad governance and defective implementations. However, due to planned efforts of various non-governmental organizations and policy makers in recent times, the government has been allocating more funds to develop female human capital in India.

In the present context, the main objective of this paper is to examine empirically, and to investigate the impact of female human capital on economic growth in Indian economy during 1970-2014. Relevant literature in examining above relationship has supported the positive contribution of gender neutral human capital on economic growth. However, the role of female human capital in economic growth is controversial in literature. Generally, education and health indicators are used as the proxy for female human capital in most of the studies. In the present context, the study used composite education and health index of

Period	SE	LPGDP	LFC	LMC	LPHY
1	0.02232	100.0000	0.0000	0.0000	0.0000
2	0.02501	94.10378	5.2955	0.5951	0.0055
3	0.03175	64.37744	22.2091	12.5654	0.8475
4	0.04078	39.74274	36.5923	22.4862	1.1786
5	0.05103	25.48884	45.6735	27.4403	1.39733
6	0.06123	17.70461	51.6987	29.0621	1.5345
7	0.07117	13.11007	55.8200	29.3491	1.7207
8	0.08089	10.17281	58.6631	29.1896	1.9743
9	0.09050	8.174249	60.6119	28.9298	2.2839
10	0.10006	6.756039	61.9476	28.6732	2.6229

Table VIII. Variance decomposition of LPGDP

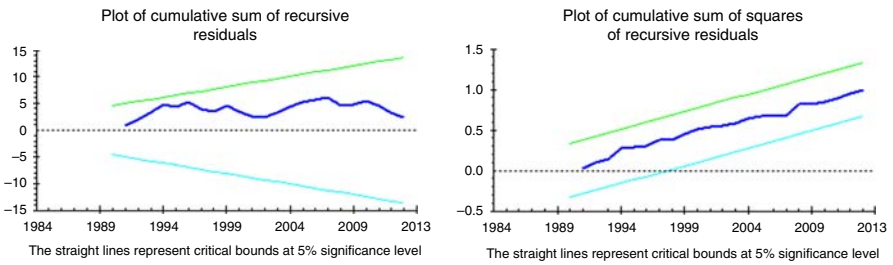


Figure 2. Stability test of the estimated model

Source: Author's own computation

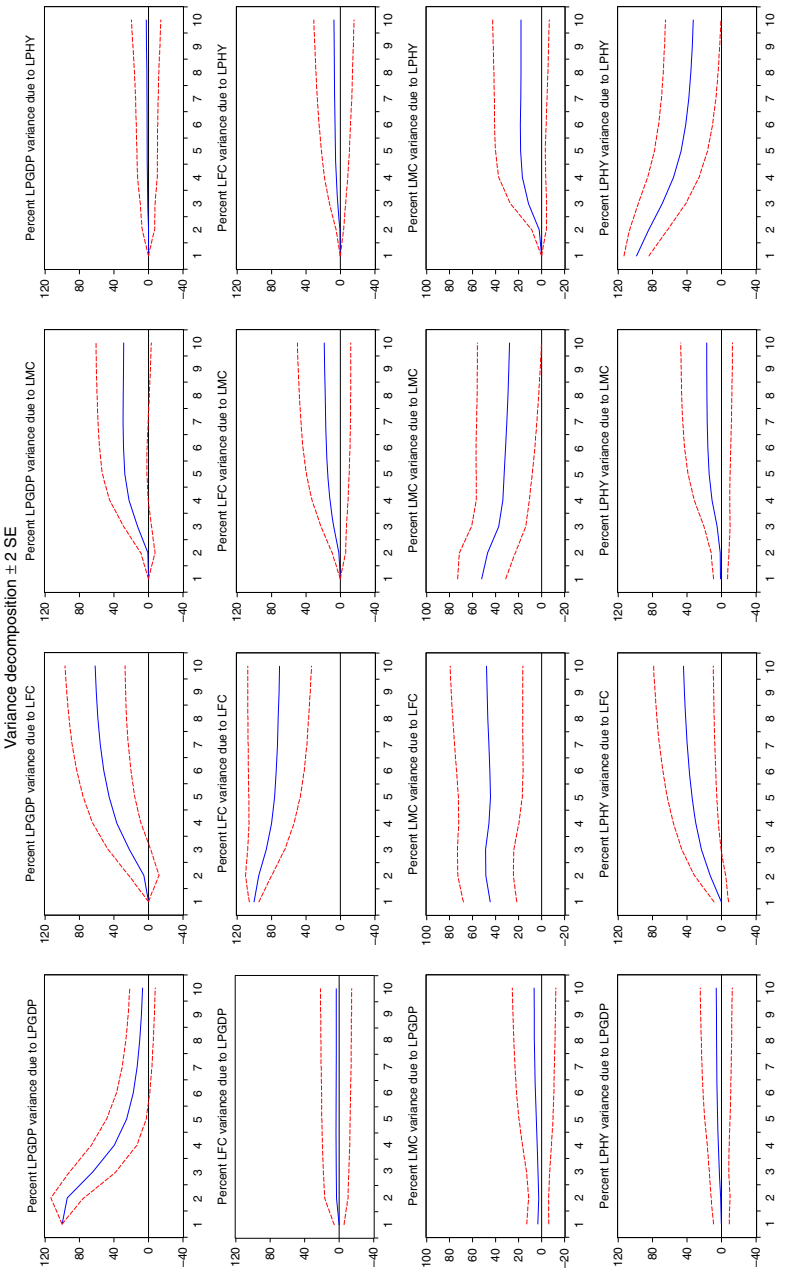


Figure 3.
Variance decomposition±2 SE

both female and male human capitals. The study also used GFCF as the proxy for physical capital. The paper employs the ARDL-bounds testing approach and the UECM to co-integration analysis, Granger's causality test to investigate the direction of the causality and variance decomposition test to capture the influence of each variable on economic growth.

The empirical results show that there exists a long run co-integration among the variables included in the model, i.e. female human capital, male human capital, physical capital and economic growth. The estimates of ARDL reveal that female human capital is significant and positively related to economic growth in both short run and long run, while the contribution of male human capital is positive but insignificant to the economic growth; same is the case of physical capital, it implies that such investment regarding female human capital needs to be reinforced so that the country can transit into the next phase of its development as a high income country.

The empirical results indicate that in the case of short run, there exists a unidirectional causality between female human capital and male human capital with economic growth. This implies that any improvement in female human capital and male human capital causes economic growth. In the long run, there is an evidence of a long-run causal relationship from female human capital, male human capital and physical capital to economic growth variable. The results of variance decomposition show the importance of the female human capital variable is increasing over the time and in the tenth period it exerts the largest influence in change in economic growth.

The results of the study are consistent with the findings of Caselli *et al.* (1996) and Khan (2016) and have not supported the findings of Barro and Lee (1994) that female capital is insignificant and negatively related to economic growth. Our result shows that both male and female human capital contribute to the economic growth. However, the female human capital is significant than male counterparts. This can be justified on the ground that female plays multivariate role in the society compared to the male counterparts. Hence, any policy that improves and empower female, its consequences are distributed to the whole society, including economic sector.

Suggestions regarding policy implications are based on the above findings and conclusions that female human capital has positive and significant role to play in influencing economic growth of the country. In this regard, it is suggested to make human capital more effective through uniform education system without any regional, social, ethnic and gender discriminations. All the educational and health institutions must maintain minimum standard regarding the quality of education and health to meet the challenges. Recommendations for the policy makers to improve women's quality of life not only for economic growth of the country, but also for sustainable development. It is also suggested that policy makers should give more attention to the poor women and rural women for improving their health and education standard.

It also suggested that women's living conditions should be improved not only for economic growth, but to empower themselves in the first place. Hence, social, economic and political empowerments of women are very much important to make their role more effective in economic growth directly and indirectly. It is recommended to empower women by revising social and cultural norms of the society. Public policies should be in line with providing equitable employment opportunities to female. Female labor force should be guided and encouraged to join the range of jobs in which they can apply their skills. Special skill development schemes for women should be given immediate priorities by the policy makers. There should also be complete elimination of gender discriminations in remunerations and promotions to female work force.

Further, removal of gender inequality by supporting women at every stage will certainly empower women socially and economically. It will also result in low fertility rate and low population growth, which is important for economic growth for developing countries like

India in ways that increase income per capita, and enhance the chance for governments to offer better health care, education and infrastructure. Further, it will also help in poverty reduction, enhance human well-being and create sustainable development. Therefore, skill levels and education opportunities for females should be increased to attain economic growth in India.

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Appendix

$$\text{Female human capital} = 1/2 \times \sum_i (Xi)$$

$$\text{Male human capital} = 1/2 \times \sum_i (Xj)$$

$$X_i = \left(X_i - X_i^*\right) / \left(X_i^{**} - X_i^*\right)$$

where X_i^{**} and X_i^* are the scaling maximum and minimum norms, such that:

$$X_j = \left(X_j - X_j^*\right) / \left(X_j^{**} - X_j^*\right)$$

where X_j^{**} and X_j^* are the scaling maximum and minimum norms, such that:X1: composite indicator on educational attainment.X2: composite indicator on health attainment.

Weights are assigned on the basis of principal component analysis:

$$\text{X1} = [(e1 \times 0.35) + (e2 \times 0.65)]$$

where $e1$ is literacy rate for the age group seven years and above (female/male) and $e2$ is adjusted intensity of formal education (Female/Male):

$$\text{X2} = [(h1 \times 0.65) + (h2 \times 0.35)]$$

where $h1$ is life expectancy at age one (female/male), and $h2$ is the infant mortality rate (female/male).

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