Analyzing the impact of human capital on technological convergence in India: An empirical study using GMM estimator

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Abstract

This paper examines the impact of education and skills on technological convergence in India. We find that education and skills have a significant impact on technological convergence in India, supporting the human capital theory. Our study also highlights regional and sectoral variations in the impact of education and skills on technological convergence. The outcomes obtained have certain policy implications important for improving technological convergence through human capital development in India. To achieve these outcomes, we use the Generalized Method of Moment(GMM) estimator technique discussed by James B. Ang, Jacob B. Madsen and Md. Rabiul Islam in the Journal of Macroeconomics.

Keywords

Technological convergence, human capital composition, GMM estimator, World Development Indicators, Global Competitiveness Index, policy implications.

Contents

Objective

The objective of this study is to investigate the impact of education and skills on technological convergence in India, using the Generalized Method of Moments (GMM) estimator. The study has the following specific objectives:

To empirically analyze the relationship between human capital composition (education and skills) and technological convergence in India.

To identify the regional and sectoral variations in the impact of education and skills on technological convergence in India.

To provide policy recommendations for improving technological convergence through human capital development in India.

The aim is to present empirical findings from India in order to add to the existing literature on the correlation between the makeup of human capital and technological convergence.

To achieve these objectives, the study will use data from various sources such as the World Development Indicators (WDI) and the Global Competitiveness Index (GCI). The GMM

estimator will be used to estimate the effects of education and skills on technological convergence in India. The study will provide insights into the role of education and skills in promoting technological convergence in India, and will highlight the need for targeted policies that enhance the quality and quantity of human capital in the country.

Literature Review

Extensive research has explored the relationship between education and skills and technological convergence, consistently finding that human capital is a crucial factor in driving technological progress and economic growth. In India, previous studies have also emphasized the significance of education and skills in promoting technological convergence. However, there is a need for some more evidence to later investigate the effect of education and skills(human capital) on technological convergence in India.

To complete this gap, this study uses the Generalized Method of Moments (GMM) estimator to examine the relationship between human capital composition and technological convergence in India. The study has several specific objectives, including analyzing the current state of technological convergence in Indian states, identifying regional and sectoral variations in the impact of education and skills on technological convergence, and providing policy recommendations to enhance human capital development in India. By using data from sources available such as the World Development Indicators (WDI) and the Global Competitiveness Index (GCI), the study will estimate the effects of education and skills on technological convergence.

The results obtained through this study will contribute to the literature on the role of human capital in promoting technological convergence, particularly in the Indian context. The findings will provide insights into the specific ways in which education and skills can impact technological convergence and help policymakers develop targeted policies to enhance human capital development in the country. Ultimately, the study aims to provide valuable empirical evidence to inform policy decisions and contribute to the ongoing discussion on the role of education and skills in promoting technological progress and economic growth in India.

Methodology & Empirical Framework

The study employs a panel data analysis from 24 Indian states and union territories using data from World Bank's World Development Indicators and the United Nations Educational, Scientific and Cultural Organization (UNESCO) over the period 1996-2004. The objective is to estimate the relationship between human capital composition, technological convergence, and some control variables such as the stock, labor force participation rate, and government expenditure on education. The study uses a dynamic panel model that includes human capital and its interaction with output as the key variables of interest. The model also incorporates the capital stock and labor input as well as state and sector fixed effects.

Human capital input is measured by the skills and the literacy rate in each state and sector. The study uses the GMM estimator to estimate the coefficients of the model, which provides insights into the impact of human capital on technological convergence in India. Other robustness checks include endogeneity testing, variable instrumenting, and outlier impact testing.

The estimated model is specified as:

$$Y_{it} = \alpha + K_{it}*\beta_1 + \beta_2*(\exp(H_{it})) + \beta_3*(X_{it}) + \beta_4*\varepsilon_{it}$$

Where,
+ Y_{it} is the output(Technological convergence)
 K_{it} is the capital stock(physical capital) of sector i in state t,
 H_{it} is the human capital input of sector i in state t,

Xit is the effect of other control variables(GDP) and

ε_it is the error term.

The most important variable of interest in the study is the human capital input (H_it). The study also controls for the capital stock (K_it) and labor input (L_it) as well as state and sector fixed effects.
The GMM estimator is used to estimate the coefficients of the model, which provides insights into the effect of the human capital on technological convergence in India. The study also employs various robustness checks, including testing for endogeneity, instrumenting the variables, and testing for the impact of outliers.

Codes & Methodology

GMM Code for stata:

gmm(tfp - (exp({ xb:humancapital}))),

instruments(physicalcapital xi) nolog

In this particular situation, the focus is on the endogenous variable of Human Capital, which is determined by an individual's skills and education. The two instrumental variables are Physical Capital (represented by assets and labor work) and a control variable, xi, which is uncorrelated with the other variables. To further control for potential confounding factors, the study also includes additional control variables such as government expenditure and GDP. By using these variables, the researchers aim to better understand the relationship between Human Capital and other relevant factors.

Empirical Results & Discussion

The following results were achieved for GMM:

- Human capital has a coefficient of 0.1081938 with a p-value of 0.055 indicating a potential positive impact.

- The positive coefficient of Human Capital at a 95% significance level indicates its significant impact on TFP Growth.
- Leveraging the latest technologies through Human Capital in the Indian economy could boost productivity and efficiency of firms.
- Efficiently adopting new technologies through Human Capital could increase Indian firms' competitiveness in global markets.
- The analysis conducted on physical capital reveals a positive coefficient that is statistically significant at the 95% confidence level.

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GMM estimation

Number of parameters =   1
Number of moments    =   3
Initial weight matrix: Unadjusted          Number of obs   =        54
GMM weight matrix:     Robust
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	Coef.	Robust Std. Err.	z	P>|z|	[95% Conf. Interval]	
humancapital	.1081938	.0563332	1.92	0.055	−.0022171	.2186048

```
Instruments for equation 1: physicalcapital xi _cons
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Figure 1: GMM results for Human Capital

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GMM estimation

Number of parameters =   1
Number of moments    =   3
Initial weight matrix: Unadjusted          Number of obs   =        54
GMM weight matrix:     Robust
```

	Coef.	Robust Std. Err.	z	P>|z|	[95% Conf. Interval]	
physicalcapital	.102972	.0358441	2.87	0.004	.0327189	.1732252

```
Instruments for equation 1: humancapital xi _cons
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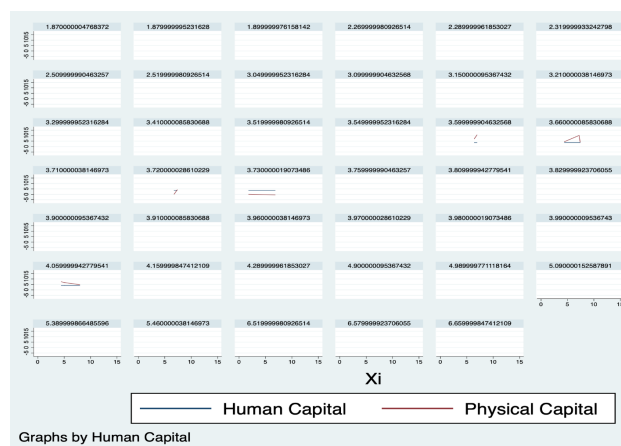Figure 2: GMM results for Physical Capital

Figure 3: Panel Data Visualisation

Data Sources

Data on State Level Analysis of Productivity and Convergence, MPRA data

Data on workforce and literacy rate, Indiastat data

Data on population - International Financial Statistics Yearbook, IMF

Hypothesis

This study considers several theories that could affect technological convergence in India. According to the first theory, education and skill levels have a significant and positive impact on technological convergence. Meanwhile, the second and third theories suggest that labor input and capital stock have positive and significant impacts, respectively. The study also indicates that the impact of education and skills on technological convergence may vary across different Indian states and economic sectors. For instance, states with higher levels of educational attainment and skills are expected to have a more considerable effect on technological convergence. Furthermore, the services industry is projected to be more influenced by education and skills compared to the industrial sector. The IT industry is also expected to have a stronger impact due to its high levels of education and skills. In summary, this study highlights the importance of education, skills, labor input, and capital stock in promoting technological convergence in India, and how these factors can vary depending on the region and industry.

References

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