International Journal of Management and Economics ISSN: 2231 – 4687
Impact Factor-6.81 (SJIF)
Vol. I No. 31 July-2020

Human Capital, Technology and Economic Growth in India

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Introduction

Economic Growth simply means increase in per capita income or increase in gross national product (GNP). In recent literature, the term economic growth refers to sustained increase in a country's output of goods and services, or more precisely product per capita. Output is generally measured in terms of GNP. The term economic development is far more comprehensive. It implies progressive changes in the socio-economic structure of a country. Viewed in this way economic development Involves a steady decline in agricultural shares in GNP and continuous increase in shares of industries, trade banking construction and services. Further whereas economic growth merely refers to rise in output; development implies change in technological and institutional organization of production as well as in distributive pattern of income.

The long run economic growth comes from technological progress but from where technological progress comes this question has led to the development of endogenous growth theory. Endogenous growth theory tries to overcome this shortcoming by making growth an endogenous variable. Several competing models have been developed by various authors. Endogenous growth theories give crucial importance to the "production" of new technologies and human capital [Arrow (1962); Romer (1986)]. In contrast to the older neoclassical growth theory, endogenous growth theory argues that policy measures can have an impact on the long-run growth rate of an economy. Subsidies on research and development or education are generally thought to increase the growth rate.

Human capital is the stock of competencies, knowledge, social and personality attributes, including creativity, embodied in the ability to perform labor so as to produce economic value. It is an aggregate economic view of the human being acting within economies, which is an attempt to capture the social, biological, cultural and psychological complexity as they interact in explicit and/or economic transactions. Economic growth closely depends on synergies between new technological knowledge and human capital. Movement from less efficient to more efficient technology symbolizes the movement towards growth. Economists have stressed increasing returns as an endogenous explanation for economic growth, in which human capital along with technological improvement plays vital role. The broad hypothesis study attempts to test is that in the changed policy regime, both human capital and technology has played an important role in increasing the productivity using Input-Output analysis.

Review of Literature

Human capital is only one factor in accounting for differences in growth rates across countries **Appleton and Teal (1998). Kim and Lee (1999)** model emphasizes that technology adoption is endogenously determined by the expected cost of technology adoption and the uncertainty related to technology shocks. According to **Fernandez and Mauro (2000)** in spite of past improvements, however the average educational attainment of the Spanish labor force is still below the European Union. **Philipson and Soares (2001)** study stress that in the standard OLG setting, longevity induced augmentation of labor has positive effects on economic growth as well as factor prices increase in longevity or health induce larger investments in human capital and, thus, increased labor productivity. **Engelbrecht (2001)** in his study re-examines the Benhabib and Spiegel (BS) results, arguing that their model does support the 'Nelson-Phelps' approach for developed economies once outliers are deleted. Moreover, if it is accepted that technology diffusion and catch-up, rather than 'human capital in levels', is the key feature of the NP approach, one has to conclude that the data support both major approaches to the modeling of human capital. **Murphy and Siedschlag (2007)** Information and communication technologies (ICT) play a central role in the transition knowledge–based economies. **Jimenez et al. (2012)** Study relies on such indicators as enrollment rates and years of schooling to measure the quantity of education and international assessments to measure quality. It has argued that a good education system is fundamental to equip workers with the right skills because an educated population earns more, and education provides people with the cushion and the life skills to avoid falling back into poverty. The tertiary education as a measure of the quality of human capital is an determinant of the economic output and it's dynamic. Investments in factors leading to the raise of life expectancy are beneficial for economic growth **Neagu (2014).**

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Data and Coverage

For analysis, the input–output tables for the years 1993-1994 and 2006-07 published by CSO, NSSO have been used. Input- output table has been converted into 29*29 sectors format.

Decomposition Effects on Productivity

The growth of productivity may be attributed to change in technology, organization structure, managerial techniques and quality of human capital. An attempt has been made to directly find out the impact of change in final demand on productivity and technology. Change in productivity due to improvement in the quality of human capital may be imputed indirectly. Effect of change in technology may be found out by using the following equation:

$$X_t = (I - A_{t-1})^{-1} C_t \quad ..(1)$$

Where X is the column vector of gross output, 'A' is matrix of technical coefficients of production, $(I-A)^{-1}$ is Leontief inverse and C is a column vector of final demand. Where t refers to the current period 2006-07 and t-1 is previous period 1993-94. The use of the preceding period's Leontief Inverse to estimate X_t from relation 1 nullifies, at least a part if not the whole, effect of the change in technology.

$$X_t = (I - A_t)^{-1} C_t \quad .. (2)$$

Differential output of (2) and (1) will furnish estimates of differential employment and productivity levels due to change in technology.

Similarly, the effect of change in final demand may also be worked out:

$\hat{X}_t = (I - A_t)^{-1} C_t$ and

$\hat{X}_t = (I - A_t)^{-1} C_{t-1}$

will furnish estimates of differential employment and productivity levels due to change final demand. Differential output due to change in final demand may manifest the human capital effect on employment and productivity. It is implicitly assumed that the change in output $\Delta \hat{X}$ embodies change in technology from the base to the terminal year. The model explicitly incorporates technological change.

Decomposition of technology and final demand effect on productivity are analyzed in the following discussion. Differential output of equation 1 and 2, will furnish estimates of differential productivity levels due to the difference of technology. The balance in the differential of output for two periods will reflect the effect of change in final demand that may also manifest the human capital effect on employment. **Table A** shows that the ***technological effect*** is the highest in 'Petroleum' followed by sectors, 'Electrical, Electronic Machinery & Appliances', 'Mining & Quarrying' and 'Construction including Cement'. Out of twenty nine sectors, there are ten sectors with negative technological effect. **Table B** highlights that the ***human capital effect*** which is high in 'Trade, Hotels, Transport, Storage and Communication', 'Other Services', 'Construction including Cement' and 'Agriculture' and low in 'Wood and Wood Products' and 'Furniture and Fixtures-Wooden'. On comparing two effects it has been found that *human capital has played more prominent role than technology in economic growth. Even the sectors which are technology driven are not without human capital effect. Thus study is clearly emphasizing the role of human capital in giving competitive advantage in improving the growth of productivity.*

Table A: Sector-wise Technological Effect (Rs. Lakhs)

Code	Industry	(1) $X_t = (I - A_t)^{-1} C_t$	(2) $X_t = (I - A_{t-1})^{-1} C_t$	(1-2)
1	Agriculture	100521409	102012099	-1490690
2	Mining & Quarrying	13793686	7086082	6707604
3	Food Products including Sugar	27379424	23868991	3510433
4	Beverages	4918192	4298363	619829
5	Tobacco products	2198268	2043256	155012
6	Textile	24738864	27280119	-2541255
7	Wood and Wood products	1106686	3102166	-1995480
8	Furniture and fixtures-wooden	1098854	1320526	-221672
9	Paper and Paper Products	3184083	4376514	-1192431
10	Printing, Publishing and Allied Activities	2743466	2493120	250346
11	Leather and Leather products	2212614	2173375	39239
12	Plastic and Rubber Products	9521218	8493739	1027479
13	Petroleum Products	27935410	12455149	15480261
14	Coal tar Products	1335215	1679555	-344340
15	Basic Chemicals	8132575	4923075	3209500
16	Other Chemical Products and Man-made Fibers	29192149	28714865	477284
17	Non-Metallic Mineral Products	6623202	3043712	3579490
18	Iron & Steel Industries and Foundries	25927352	27408678	-1481326
19	Other Basic Metals Industry	5625216	1318166	4307050
20	Metal Products except Machinery and Transport Equipment	10875344	8078937	2796407
21	Agriculture, Industrial, General & Special purpose Machinery	18025344	14471012	3554332
22	Electrical, Electronic Machinery & Appliances	37427313	27825815	9601498
23	Railway Transport Equipment	1339788	1946463	-606675
24	Other Transport Equipment	13844842	14302374	-457532
25	Miscellaneous Manufacturing	12100619	8432203	3668416

	Industries			
26	Construction including cement	93722528	87871130	5851398
27	Electricity and Water Supply	19222693	27179466	-7956773
28	Trade, Hotels, Transport, Storage & Communication	159023619	154061139	4962480
29	Other Services	126945873	128011494	-1065621

Source: Calculated from *NSSO*, CSO

Table B: Sector-wise Human Capital Effect (Rs. Lakhs)

Code	Industry	(1) $\hat{X}_t = (I - A_t)^{-1} C_t$	(2) $\hat{X}_t = (I - A_t)^{-1} C_{t-1}$	(1-2)
1	Agriculture	100521409	32131979	68389430
2	Mining & Quarrying	13793686	4093273	9700413
3	Food Products including Sugar	27379424	5663463	21715961
4	Beverages	4918192	481218	4436974
5	Tobacco products	2198268	857666	1340602
6	Textile	24738864	5792245	18946619
7	Wood and Wood products	1106686	445353	661333
8	Furniture and fixtures-wooden	1098854	175459	923395
9	Paper and Paper Products	3184083	671448	2512635
10	Printing, Publishing and Allied Activities	2743466	718959	2024507
11	Leather and Leather products	2212614	729647	1482967
12	Plastic and Rubber Products	9521218	2011854	7509364
13	Petroleum Products	27935410	4901822	23033588
14	Coal tar Products	1335215	223552	1111663
15	Basic Chemicals	8132575	1667758	6464817
16	Other Chemical Products and Man-made Fibers	29192149	6548529	22643620
17	Non-Metallic Mineral Products	6623202	1544215	5078987
18	Iron & Steel Industries and Foundries	25927352	3690392	22236960
19	Other Basic Metals Industry	5625216	1676531	3948685
20	Metal Products except Machinery and Transport Equipment	10875344	2159862	8715482

21	Agriculture, Industrial, General & Special purpose Machinery	18025344	2986178	15039166
22	Electrical, Electronic Machinery & Appliances	37427313	4144205	33283108
23	Railway Transport Equipment	1339788	481652	858136
24	Other Transport Equipment	13844842	2292219	11552623
25	Miscellaneous Manufacturing Industries	12100619	2908570	9192049
26	Construction including cement	93722528	12546795	81175733
27	Electricity and Water Supply	19222693	3827022	15395671
28	Trade, Hotels, Transport, Storage & Communication	159023619	30366723	128656896
29	Other Services	126945873	23769463	103176410

Source: Calculated from *NSSO*, CSO

Conclusion and Policy Implications

Thus, detailed analysis of technology, human capital and productivity growth emphasizes that, both the technology and human capital play an important role in growth. However human capital has played more prominent role than technology in economic growth. Obviously, the growth process has been based on factor transformation process in many sectors. In the era of knowledge economy, government must draw more attention towards education improvement. The human resource plan needs to be flexible enough to meet short-term staffing challenges, while adapting to changing conditions in the business and environment over the long-term. It is not merely spending more on human capital that translates it into higher profitability but more important is that how they are managed and integrated with other business functions to achieve higher profitability. It is not just the process of buying the technology that gives performance, rather efficient and trained human capital and its capabilities to effectively coordinate internal and external competencies also matter a lot.

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