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Human Capital, Technological Spillover and Productivity of Manufacturing Sector: A Comparative Analysis of Pakistan and India

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ABSTRACT

The momentous goal for a developing country is to achieve the accelerated and sustained economic growth. In pursuance of this, creditable objectives and identification of the variables which are capable of accelerating growth are needed. Total factor productivity (TFP) is considered as an important factor for economic growth. TFP is measured as residual using the Growth Accounting approach. The Solow's residual accounts for the portion of output could not be described by the growth of inputs. Increased productivity level is a prerequisite to attain higher level of output for the same level of input. The research has been conducted in subcontinent for exploring the role of human capital (HC) in increasing the productivity however the role of technological spillovers (TS) has not been investigated in detail, specifically in case of Pakistan. In this background the study investigated the impact of HC and TS on manufacturing productivity for both India and Pakistan using time series data from 1980-2014. Johanson's Co-integration Approach and Vector Error Correction Model (VECM) were employed to investigate the long run and short run relationship among the variables. The results reveal the existence of long run relationship among HC, Research & Development (R&D) Expenditure and TFP variable. The estimated results of the models show the positive significant influence of human capital and technological spillover on manufacturing productivity for both countries. The results imply that investment in human capital, R & D Expenditure and Technical Cooperation Grants result in increased productivity. So there is need to devise the policies for the development of human capital and enhancing Research & Development expenditure over time.

Keywords: Human Capital, Productivity, Technological Spillover, VECM

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1. INTRODUCTION

The momentous macroeconomic goal of a developing country is the achievement of accelerated and sustained economic growth. In pursuance if this creditable objective, identification of the variables which are capable of accelerating growth, is needed. Total factor productivity is one of the contributory factors for economic growth. Increased productivity level is a requisite to attain higher level of output for the same level of input. Steady growth of both, i.e. inputs and productivity are requisites for higher growth of an economy. Productivity is the measure of efficiency of inputs used. Ahmad et al. (2010) found a positive impact of productivity growth on output and investment growth.

Research and development activities influence economic development directly and indirectly. A firm that undertakes its own R&D activities is likely to have larger market share and increased profits because of the advantages associated with innovation of its products and processes(Pradhan et al., 2020). Foreign presence in the country particularly becomes more beneficial in diffusion of technological spillovers from foreign firms if the domestic firms undertake their own R & D and have increased absorptive capacity (Bahera, 2015). Technological spillovers effect facilitates of a country to catch up with technologically advanced countries and regions. Imported inputs that optimize technology are more effective in increasing the output. Knowledge capital and human capital are vital determinants of productivity and competitive growth of firms in Pakistan (Siddiqui & Mehmood, 2006). The extent to which a country invents new technology and simulates the already existing non-native technologies depends on its level of human capital (Romer,1990). Well-developed human capital is considered as the essential element for the growth of developed countries. Similarly, developing economies that are performing well are closer to developed countries in human capital standards (Todaro, 2011).

Technology and technological innovations are the externalities of research and development investments(Pan et al., 2021). Developing countries can supplement this deficiency by importing and adopting technology from the developed world. The manufacturing industry of a country must invest within its own absorptive capacities to benefit from the external R&D investment (Ali et al., 2012). Technical cooperation grants include the grants provided to the citizens acquiring training or education either at home or abroad and they belong to the countries which receive aid. These grants are also allocated to the people who are serving in aid recipient countries like consultants and teachers etc. Human capital of a country is another key determinant of productivity(Jibir et al., 2023). Human capital refers to skills, knowledge, and sophistications. The more abundant a country is in it, the more positive influence will it have on productivity and output. The extent to which a country invents new technology and simulates the already existing non-native technologies depends on its level of HC (Romer, 1990).

Taking into account the positive role of HC and technological adoption on the growth at micro and macro level, this study is designed to analyze the role of both human and technological impact on productivity of manufacturing sector in Pakistan and India by utilizing the Growth Accounting approach and Johanson's cointegration technique. For both India and Pakistan, research has been conducted for exploring the role of HC in increasing the productivity but the role of technological spillovers is relatively neglected area, specifically in case of Pakistan. In this background the study investigated the impact of HC and technological spillovers on manufacturing productivity for both India and Pakistan. Moreover, Pakistan and India both are labor abundant developing countries and manufacturing sector can play a key role in provision of employment to a large number of labor force.

The organization of the study is as follows: Existing literature is reviewed in section-II. Section-III contains the theoretical basis for the growth accounting approach to measure TFP growth and relationship between TFP growth, HC and technological spillover. Section-IV discusses the methodology, estimation and results. In that section, a comparative analysis has also been made and in section-V the study is concluded.

2. LITERATURE REVIEW

Technological advancement helps to improve productivity and accelerates the rate of economic growth. Siddiqui & Mehmood (2000) analyzed time series data of Pakistan for the period 1972-1997 and reviewed productivity trends in manufacturing industry and analyzed the significance of R&D activities to accelerate productivity According to their reported results, knowledge capital explained 30% variation in productivity growth and HC explained 18% variation. Griffith, Redding & Reenen (2004) conducted an empirical study and found the importance of R&D for productivity. R&D served as a catalyst across OECD countries in the convergence of TFP levels within industries, moreover HC triggered innovation and the absorptive capacity. Falk (2007) investigated the effect of expenditure on R& D and long run economic development in OECD countries. He used panel data spanned over the period 1970-2004. His estimates depicted a long run association between investments in R & D especially in high-tech sector and economic growth. He estimated the impact of expenditure made by business enterprises in R & D and found its positive impact on productivity and economic growth.

HC has always been important for economic growth & development. Matousek & Tzeremes (2021) investigated the asymmetric impact of HC on economic growth by studying 100 countries. They found the HC positively impact economic growth of any country. Abbass & Peck (2008) in their analysis related to impact of HC on economic growth of Pakistan over the period 1960-2003, found a substantial role of HC in accelerating economic growth and found that HC enhances a country's absorption of world's technical advancements. Technological progress of a country depends on its absorptive capacity. Knowledge HC is very crucial for increasing absorptive capacity. They also reported under-investment in knowledge HC due to which the country could not properly exploit the opportunities generated by world technical progress.

Owing to the importance of HC for increased productivity levels of a country, a study was conducted by (Afroz et al., 2010). This observation was supported by results estimated by employing two-way error components of fixed effect model. Estimated value of parameter for educated workers was 0.14 and that for parameter of skilled workers was 0.42. Higher value of the parameter of skilled workers implies that HC is more effective for increasing productivity as compared to the ratio of capital to workers.

Kathuria et al. (2010) studied the impact of HC on manufacturing productivity in India. They used firm level data for both formal and informal manufacturing sectors over the period 1995-2004. They used Cobb. Douglas production function to estimate TFP for both sectors and then used the TFP estimates to check the relationship between HC and manufacturing productivity. They found that there existed a positive impact of HC on productivity especially in the informal sector. Ghosh & Parab, (2021) assessed the Indian economy's productivity trends caused by HC, technology and FDI. In their findings they recommended sustained increase in HC and FDI.

R & D activities actually increase absorptive capacity. To what extent a firm benefits from external technology depends on how much the firm has the capability to absorb the TS. Absorptive capacity of a firm depends on market structure, HC and firm's own R & D contribution. HC helps in enlarging the absorptive capacity of different sectors. Similarly, more competitive firms are inclined to absorb TS to a greater extent (Dalgic, 2013).

Foreign technology via its spillover effects helped Indian industries in improving their technology level. In an empirical study by Behera, Dua & Goldar (2014), spillover effects were found significant in all sizes of firms and had led to log run relationship between TS and labor productivity. They found that technical spillovers were higher in food products, chemicals, textiles, drugs, pharmaceuticals and in non-metallic mineral products industries. There existed a long-lasting association between labor productivity along with its determinants with knowledge spillovers. Total factor productivity was found dependent on extent of R & D undertaken by domestic as well as foreign firms and also on their import intensity. Firms that lagged behind on technological front and had reduced absorptive capacity due to their technological gap bore negative impacts on productivity. On average foreign presence in the country led to increased productivity, knowledge and R & D spillovers.

Behera (2015) empirically studied influence of technology spillovers on Indian manufacturing sector and concluded that investment from abroad created new dimensions of knowledge and technology spillovers for Indian industries. He found influence of R&D intensity and technology import intensity on domestic firms. According to the estimated results foreign presence in the country, particularly becomes more beneficial in diffusion of technology spillovers from foreign firms if the domestic firms have high absorptive capacity. It was also observed that foreign investment was likely to be made in the country due to larger size of the market and increasingly productive indigenous sectors.

Jacobs, Nahius & Tang (2000) , Gorg & Stroble (2001), Medda & Pegga (2007), Aspergis, Economiduo & Filippidis (2009), Ali *et al*. (2012) and Wang & Mu (2012) found that R & D and the R & D spillovers from both the domestic and international sources have a positive and significant role in increasing productivity. Singh & Pratap (2016) found a strong linkage between TS and manufacturing productivity in India. Ilegbinosa (2013) ,Khan & Khatak (2013), Lebdenski & Vandenberghe (2014) studied human development as an effective tool for economic development. Victoria & Jaiyeoba (2015) argued that investment in HC through its spillover effects on different sectors of economy helped in increasing output. The review of existing empirical literature showed that HC and TS have positive impact on the manufacturing productivity and both are important for increasing the productivity.

3. THEORETICAL FRAMEWORK AND MODEL SPECIFICATION

Solow's (1956) growth model (neo-classical framework) states that labor force and capital stock increase output of an economy temporarily due to decreasing returns to scale. On reaching steady state (a state when investment equals depreciation), the rate of economic growth can be raised only through technological improvements. In growth accounting approach TFP is measured as residual by using Solow's residual accounts for the portion of output which could not be explained by the growth of inputs (Ahmad, 2011).

Starting with the production function as given below:

$$Y = AK^{\beta 1}L^{\beta 2}$$

$$dY = \frac{\partial f}{\partial A}dA + \frac{\partial f}{\partial K}dK + \frac{\partial f}{\partial L}dL \ldots\ldots\ldots\ldots\ldots 1$$

$$dY = f_A.dA + f_K.dK + f_{L.} \ldots\ldots\ldots\ldots\ldots\ldots 2$$

by differentiation of both sides

$$\frac{dY}{dt} = f_A\frac{dA}{dt} + f_K\frac{dK}{dt} + f_{L.}\frac{dL}{dt} \quad \ldots\ldots\ldots\ldots\ldots\ldots 3$$

yields the growth rates.

Division of both sides by Y and rearrangement yields the following equation.

$$\frac{dy/dt}{Y} = f_A\frac{dA/dt}{Y} + f_K\frac{dK/dt}{Y} + f_{L.}\frac{dL/dt}{Y}$$

$$\frac{dY/dt}{Y} = \frac{A.\partial f/\partial A}{Y}\frac{dA/dt}{A} + \frac{K.\partial f/\partial K}{Y}\frac{dK/dt}{K} + i\,\frac{L.\partial f/\partial L}{Y}\frac{dL/dt}{L} \quad \ldots\ldots\ldots\ldots\ldots\ldots 4$$

In this equation, the term $\frac{A.\partial f/\partial A}{Y}\frac{dA/dt}{A}$ expresses the rate of shift with respect to its proportion.

$\frac{\left(\frac{\partial F}{\partial k}\right)}{y}$ represents capital share in output which is expressed as sk

$\frac{\left(\frac{\partial F}{\partial L}\right)}{Y}$ represents labor share in output which is expressed as sl

Now, the renewed form of equation 5 is

$$y = TFPG + skK + slL \quad \ldots\ldots\ldots5$$

By re-arranging above for productivity we can find

$$TFPG = y - skK - slL \quad \ldots\ldots\ldots6$$

And this is the equation to estimate the TFP.

Alternatively it can be written as

$$TFPG = y - \alpha K - (1 - \alpha)L \quad \ldots\ldots\ldots..7$$

In equation 7 α represents share of capital 1-α represents the share of labor.

The proposed empirical model is given as

$$TFP_t = f\,(HC_t\,,\, R\&D_t\,,\, TCG_t)$$

$$TFP_t = \alpha_0 + \alpha_1 \ln(HC_t) + \alpha_2 \ln(R\&D_t) + \alpha_3 \ln(TCG_t) + U_t$$

Where

TFP represents Total factor productivity and measured as residual, HC for Human capital, R&D represents Research and Development Expenditure, and TCG represents Technical Cooperation Grants.

α_0, α_1, α_2 and α_3 are the desired parameters to be estimated and U_t the stochastic error term.

In order to estimate the impact of HC, and TS on manufacturing sector productivity, Co-integration and error correction model techniques were employed.

3.1. Description of Variables

TFP is the unexplained part of output calculated as a residual and expressed as the portion of output which is not explained by the amounts of inputs used in production. And, for this study it is measured as Solow's residual. Human capital (HC) refers to the skills and capabilities of individuals which affects their productivity and earning. Primary enrolment ratio has been used as proxy for human capital. Theoretically it is expected to positively influence the TFP. R&D expenditure has been used as a proxy for technological spillovers. OECD defines

Research and Development expenditure as expenditure on research performed to increase the stock of knowledge and to use this knowledge to create new processes and techniques. This too is expected to have a positive impact on TFP. Technical Co-operation Grants (TCG) includes assistance in the form of transfer of technology or technological skills and grants to support certain investment projects. TCG too is used as a proxy for technological spillovers.

Formal and informal methods are used to detect the presence of unit root in time series data**.** Among formal methods, Augmented-Dicky Fuller test is widely used for the detection of unit root in time series data. Augmented Dickey-Fuller (ADF) test is conducted on all the variables to verify whether the variables are stationary or possess the unit root and to check for the order of integration of the variables.

4. METHODOLOGY, ESTIMATION AND RESULTS

This section presents the results of growth accounting approach utilized to estimate the manufacturing productivity trends in both countries and the results of co-integration analysis for both countries. Before co-integration analysis productivity of manufacturing sectors for both countries is measured.

4.1. Manufacturing Productivity and Co-integration analysis results for India

4.1.1 TFP (Solow's residual)

The following equation estimates TFP growth rates.

$$TFP_G = V - 0.91K - .09L$$

Where TFP_G represents growth rate of TFP of manufacturing sector, V represents growth rate of value added, K represents Capital growth rate and L represents Labor growth rate. In the above equation share of capital shows that manufacturing sector in India is capital intensive because it indulges in more capital-intensive techniques for production in sectors related to manufacturing than countries at similar development level (Hasan. R,.et al, 2013).

4.1.2 Trends in Manufacturing Sector

Table 1: *Growth Rates of Value Added, Capital, Labour and TFP For India (in %)*

Growth Rates	1980-1989	1990-1999	2000-2009	2010-2014	1980-2014
Value Added	-0.5776	6.2321	3.3139	8.0210	3.8244
Capital	-1.2674	5.1251	3.5172	5.1441	2.9628
Labour	0.6997	0.7889	-0.6972	2.1935	0.5348
TFP	-0.0099	0.3181	0.4939	0.6835	0.3268

The table 1 reports the trends in manufacturing sector of India during the period 1980-2014. Manufacturing value added on average grew at 3.8244 percent per annum. This growth rate remained -0.5776 percent during 1980's. Ahluwalia (1991) also reported 0% annual average growth rates of labor and factor productivity in Indian manufacturing sector in 1979-1980. The reason for such low level of productivity growth rate was the failure of the economic policies regarding decentralization and state control of the heavy industries, Import-substitution and rigid price controls etc. It was highest at 8.0210 during the period from 2010-11 to 2014-15. Capital growth rate averaged 2.9628 percent annually and it was recorded negative during 1980's. Growth rate of capital was recorded highest at 5.1441 during 2010-11 to 2014-15. Labor forced employed on average grew at 0.5348 percent, its growth rate was recorded negative during 2000's and was recorded 0.6997 percent and 0.7889 percent during 1980's and 1990's respectively. It remained 2.1935 during 2010-11 to 2014-15.TFP growth rate was recorded negative during 1980's and increased gradually till 2014 it reached 0.6835. On average, every year TFP grew 0.3268 percent.

4.1.3 Unit-Root Test Results

The table below shows results of unit root test (Augmented Dickey-fuller) at level and at first difference. It is clear from the reported critical values and probability values that are reported in the last column of the table 2 that none of the variables is found to be stationary at level

Table 2: *Results of ADF Unit Root Test for India*

Variables	ADF Stat	T. Statistic	Prob.	Results
At Level				
lnTFP	-2.25	-3.54	0.44	NS
lnHC	-0.49	-2.95	0.88	NS
lnRD	-1.97	-3.54	0.59	NS
lnTCG	-1.77	-3.54	0.69	NS
At First Difference				
lnTFP	-3.82	-3.55**	.0284	S I(1)
lnHC	-3.44	-2.95**	.0165	S I(1)
lnRD	-4.06	-3.55**	.0163	S I(1)
lnTCG	-4.03	-3.55**	.0173	S I(1)

** indicate that differenced variables are stationary at 5% level of significance. NS stands for non-stationary whereas S stands for stationary.

4.1.4 Co-integrating Approach

Table 3: *Co-integrating Equations for INDIA (TRACE and MAX-EIGEN Statistics)*

Hypothesized No of CE(s)	Eigenvalue	Trace Statistics	0.05 critical value	Prob.**
None*	0.4943	48.8490	47.8561	0.0402
At most 1	0.3636	26.3469	29.7970	0.1186
At most 2	0.2873	11.4313	15.4947	0.1863
At most 3	0.0076	0.2531	3.8414	0.6149

**indicates rejection of hypothesis at the 5% level. The lag interval is 1 to 1.

There is reported one co-integrating equation by the Trace statistics. Existence of the co-integrating equations suggests that the variables possess the capability to move together, as well as to determine and maintain a relationship in the long run. The Johansen's co-integration test detects at least one co-integrating relationship among lnTFP, lnHC, lnR&D, and lnTCG. Results of trace statistic and maximum eigenvalue statistics generate contradictory results, regarding the significance level of co-integrating relationships. In such situations, more importance should be given to trace statistics, because trace statistic considers all of the smallest eigenvalues, it holds more power than the maximum eigenvalue statistic (Kasa,1992; Serletis & King, 1997). Johansen & Juselius (1990) also advocated for the use of the trace statistic when the results produced by these two statistics tend to be different. Therefore, one co-integrating relationship is evident from the trace statistics.

4.1.5. Co-integrating Equation Results

The equation below reports the results normalized co-integrating equation for India.

$$\ln TFP = 1.111424 \ln HC + 0.061428 \ln R\&D + 0.347059 \ln TCG$$

	lnHC	lnR&D	lnTCG
Std.error	(0.19552)	(0.02270)	(0.04754)
t-ratio	5.6844	2.7060	7.3003

TFP is evidently observed to be influenced positively by lnHC, lnR&D, and lnTCG. This is reported by the normalized coefficients presented above. The signs of all the variables are in accordance with expectations. All variables have a significant impact on productivity of manufacturing sector. The coefficients of the normalized equation imply that a percentage change in the lnHC raised TFP by 1.111% percent. Similarly change in lnRD by 1% pushed the TFP by 0.061 % and 1% increase in lnTCG raised TFP by 0.347%.

4.1.6. Vector Error Correction Model Results

The equation below reports the VECM results for India.

ΔTFP =	0.00829	-0.30265 ΔTFP_{t-1}	+0.29922 $\Delta lnHC_{t-1}$	-0.08511 $\Delta lnR\&D_{t-1}$	- 0.10235 $\Delta lnTCG_{t-1}$	- 0.40112 ECT_{t-1}
Std.error	0.01888	0.17680	0.29450	0.11627	0.08496	0.17828
t-ratios	0.43953	1.71179	-1.01606	0.73203	1.20475	-2.24997
p-values	0.6612	0.0898	0.3119	0.4657	0.2309	0.0265

The estimated equation depicts the accurate negative sign of ECM coefficient having value -0.401122 suggesting that in each period 40% of the disequilibrium could be corrected. P-value (0.0265) of ECM coefficient is lower than 5% of level of significance which establishes the significance of ECM co-efficient. In this model the value of R-square is 0.28 which represents that 28% of the volatility in TFP is caused by the explanatory variables and their lagged values. In short run lnR&D & lnTCG though have positive signs but none of the independent variable show significant impact on dependent variable and it might be due to the fact that policies need a longer period to be proven fruitful. The possible outcome of a policy can be different in short run and in long run.

Residual Serial Correlation LM Test accepts no serial correlation hypothesis because the reported probability value 0.85 is higher than the probability value at which the null hypothesis about the non-existence of serial correlation is rejected.

4.2 Manufacturing Productivity and Co-integration analysis results for Pakistan

4.2.1 TFP (Solow's residual)

The following equation estimates TFP growth rates.

$$TFP_G = \hat{V} - 0.7499\,\hat{K} - .2501\hat{L}$$

Where TFPG represents growth rate of TFP of manufacturing sector, V represents growth rate of value added, K represents Capital growth rate and L represents Labor growth rate. In the above equation share of capital shows that manufacturing sector of Pakistan uses more capital-intensive techniques of production. Yousaf & Amjad (2014) and Amjad & Awais (2016) also reported capital intensity of the manufacturing sector of Pakistan.

4.2.2 Trends in manufacturing sector

Table 4: *Growth Rates of Value Added, Capital, Labour and TFP for PAKISTAN (in %)*

Growth Rates	1980- 1989	1990-1999	2000-2009	2010-2014	1980-2014
Value Added	1.6562	4.7330	14.5207	3.5072	5.3877
Capital	-0.5530	2.8981	6.6424	-1.2729	2.6675
Labor	1.1331	0.3207	6.2648	3.0496	1.0630
TFP	1.0760	1.5141	1.6134	1.7305	1.6571

The average annual growth rate of the manufacturing value added have been 5.3877% over the period. This growth rate was found out to be lowest during 1990's at 1.6562% and highest, 14.5207 %, during the first decade of the century. Capital growth rate averaged 2.66 percent annually and it was as low as -1.2729 percent during the period 2010 -2014. Growth rate of capital was recorded highest during 2000's. Labour force employed on average grew at 1.0630 percent, its growth rate remained low during 1980's and 1990's , increased during the period from 2010 to 2014 to 3.0496 percent and attained its highest growth rate during the period from 2001-2010. TFP growth rate averaged 1.6571 annually and it remained lowest during 1980's and recovered to the highest level of growth, 1.7305 during the period from 2010 to 2014. In 1980's market friendly policies were implemented which accelerated the manufacturing productivity growth in Pakistan. Manufacturing productivity declined in 1990's. Political instability during 1990's was the major contributory factor in this decline. The political governments being unable to complete their tenures could not pay attention to the worsened Law and Order situation in the country. Moreover, the country also faced power shortage problems during 1990's. Ahmed (2005) also observed the similar trends in in manufacturing growth rates. In his analysis, the productivity growth rate was also observed low during 1990's as compared to the 1980's. Later on, during the first half of 2000's it experienced a rising trend.

4.2.2 Unit Root Test Results for Pakistan

Tables below presents the results of the Augmented Dicky-fuller test to check for the order of integration of the variables, both at level and at first difference for Pakistan as earlier it was carried out for India. Table 5 reports all the variables to be non-stationary at level.

Table 5: *Results of ADF Unit Root test for PAKISTAN*

Variables	ADF Stat	T. Statistic	Prob.	Results
At Level				
lnTFP	-2.49	-3.54	0.32	NS
lnHC	-1.49	-3.54	0.81	NS
lnR&D	-3.10	-3.54	0.12	NS
lnTCG	-2.39	-3.54	0.37	NS
At First Difference				
lnTFP	-6.30	-3.55**	0.0001	S I(1)
lnHC	-4.35	-3.55**	0.0082	S I(1)
lnR&D	-8.39	-3.55**	0.0000	S I(1)
lnTCG	-4.50	-3.55**	0.0058	S I(1)

** indicate that differenced variables are stationary at 5% level of significance. NS stands for non-stationary whereas S stands for stationary.

The ADF results and the respective probability values confirm that integration order of the variables are I(1). All variables are stationary at first difference.

4.2.3 Co-integrating Equations

The table 5 reports results for testing the number of co-integrating vectors. Trace test statistics results are reported in the table. The last column shows probability values; the (nonstandard distribution) critical values reported here are slightly different from the critical values reported by Johansen & Juselius (1990), because these are taken from MacKinnon-Haug-Michelis (1999).

Table 6: *Co-integrating Equations for PAKISTAN (TRACE and MAX-EIGEN Statistics)*

Hypothesized No of CE(s)	Eigenvalue	Trace Statistics	0.05 critical value	Prob**
None*	0.5368	51.1703	47.8561	0.0236
At most 1	0.3829	25.7675	29.7970	0.1358
At most 2	0.1685	9.8341	15.4947	0 .2973
At most 3	0.1017	3.7416	3.8414	0.0531

* indicates rejection of the hypothesis at the 0.05 level.

The trace statistics indicates existence of one cointegrating equation. The trace statistics shows one co-integrating vector and rejects the hypothesis of no co-integration.

4.2.4 Co-integrating Equation Results

lnTFP =	0.237092lnHC	+ 0.286978lnR&D	+ 0.167714lnTCG
Std.error	0.07972	0.04863	0.05530
t-ratios	2.97389	5.90100	3.03292

The normalized equation coefficients describe the long run behavior of variables of the model. All the variables show the expected positive sign and are significant as well. Manufacturing productivity in Pakistan is evidently being influenced by human capital and technological spillover. The coefficients of the normalized equation imply that with 1% change in the lnHC ,TFP raises by 0.2370% percent. Similarly change in lnR&D by 1% pushed the TFP by 0.2869 % and 1% increase in lnTCG raised TFP by0.1677%.

4.2.5 Vector Error Correction Model Results

The following equation represents the VECM results for Pakistan.

$\Delta TFP = 0.21716 - 0.221838\,\Delta TFP_{t-1} - 0.151818\,\Delta lnHC_{t-1} + 0.044931\Delta lnR\&D_{t-1}$

Std. error	0.01490	0.18756	0.22390	0.02600	0.04541	0.11040
t-stat	1.45784	1.1827	0.67806	-1.72817	-1.4925	-2.83251
p-values	0.1478	0.2395	0.4992	0.0868	0.1386	0.0055

The estimated equation depicts the accurate negative sign of ECM coefficient having value -0.3126988 suggesting that in each period 31% of the disequilibrium could be corrected. P-value (0.0055) of ECM coefficient is lower than 5% of level of significance which establishes the significance of ECM co-efficient. In this model the value of R-square is 0.30 which represents that 30% of the volatility in TFP is caused by the explanatory variables and their lagged values. Human capital exhibits the expected sign but its coefficient is not significant, lnR&D coefficient too has a inverse sign but it is significant during the short run. Given the LM-stat and the probability value, the null hypothesis of no serial correlation is not rejected that negate the presence of serial correlation in variables of estimated model.

Results reported for both countries are in line with previous empirical findings of Siddiqui & Mehmood (2006) who found that knowledge capital and human capital are vital determinant of productivity and competitive growth of firms in Pakistan, Behera (2015) and Parameswaran (2009) found positive impact of R&D spillovers on productivity in Indian manufacturing industries. Hamid & Pichler (2009), Olayemi (2012), Ilegbinosa (2013), Victoria and Jayieoba (2015) and Jacobs, Nahius & Tang (2000) also reported positive and significant role of human capital on productivity.

Aspergis, Economiduo & Filippidis (2009) reported long run association between total factor productivity, technology transferred and human capital. The present study and the results reported from other studies confirm the substantial role played by human capital and technological spillover on manufacturing productivity. India and Pakistan both are developing nations and developing countries are characterized by low industrialization and lower productivity levels. To attain development and economic growth, both countries must focus on increasing the productivity levels. The positive impact of human capital and technological spillover on manufacturing productivity in both countries is encouraging and it shows that increased stock of knowledge human capital and increased technological spillovers will prove helpful in achieving higher productivity levels in both countries. Developed countries have higher absorptive capacities and possess high levels of human capital whereas the developing countries lag behind and don't catch up with developed countries due to low absorptive capacities. Technological spillovers assist technical progress that depends on the absorptive capacity of a country and this capacity depends on knowledge human capital. Therefore, the technology embedded spillover and the stock of human capital are of crucial importance for both countries.

5. COMPARATIVE ANALYSIS OF PAKISTAN AND INDIA

Manufacturing sector plays a key role in economic growth of a country. India and Pakistan both are developing countries and increased manufacturing productivity is essential for the development of both countries. An empirical analysis of manufacturing sector of both countries is made to observe the trends in their productivity. The key finding of the analysis is that the manufacturing sector in both countries performed well when there was a progressive change in economic policies. In India productivity followed an upward trend after 1991's economic reforms. During 1980's productivity remained lowest, because rigid policies were being perused at that time. The change in economic policies proved beneficial for manufacturing sector in India. In case of Pakistan too feasible economic policies and suitable environment were found to be inevitable for the enhancement of productivity. Contribution of manufacturing productivity to value added growth of Pakistan remained highest during 1980's due to market friendly policies during the period and it declined during 1990's due to the prevailing political conditions in the country (Ahmed, 2005). Productivity followed a downward trend during the period 2001-2010 due to the then prevailing political conditions, the state of power sector, and terrorism that had adversely affected Pakistan for its role in war against terrorism during 2nd half of 2000's, led to contraction in manufacturing productivity. After finding the manufacturing productivity in both countries, an attempt has been made to empirically analyze the impact of Human capital and technological spillovers on productivity. These two factors are found very crucial for manufacturing productivity in both countries. Both the human capital and the technological spillovers have a long run association and a positive impact on productivity in both countries which confirms the importance of human capital and technological spillovers for increasing manufacturing productivity in both neighboring countries. Comparison of the two countries on the basis of coefficients of the independent variables shows that India has performed well in education sector as the change caused by human capital in TFP is larger than that in case of Pakistan. While R & D expenditure has influenced TFP in manufacturing sector of Pakistan more than its influence in Indian manufacturing sector. TCG have a larger coefficient value in India as compared to that of Pakistan, which shows that TCG have been more effective in increasing the TFP in India than Pakistan. Moreover, the ECT term for both countries is correctly signed i.e. negative and significant for both countries. The speed of adjustment towards equilibrium is higher, 0.40 in India whereas it is reported to be 0.31 in case of Pakistan implying that 0.40% and 0.31% of the disequilibrium could be corrected in each one period in India and Pakistan respectively. The speed of adjustment implies that Indian manufacturing sector will attain equilibrium in almost two to three more periods while it will take almost three to four more years for manufacturing sector of Pakistan to attain long run equilibrium. On the basis of these finding it can be concluded that the overall performance of Indian manufacturing sector is better than that of Pakistan and India has reaped greater benefits of human capital and technological spillovers in increasing productivity of its manufacturing sector.

6. CONCLUSION

The study empirically examined the influence of human capital and technological spillovers on manufacturing productivity in India and Pakistan for the period 1980-2014. Johanson & Juselius (1991) Co-integration analysis and VECM have been used to test the long run and short run association among variables respectively. The analysis of the long run test revealed that human capital, research and development expenditure and technical cooperation grants maintained a positive relationship with TFP in the long run, in both India and Pakistan. The positive and significant coefficients of the independent variables i.e., Human capital, Research and development expenditure and Technical co-operation grants imply that investment in human capital, increased R & D spending and technical cooperation will result in increased productivity in both countries**.** India and Pakistan both are developing countries therefore increased productivity level is essentially the prerequisite for both the countries to get economically developed. Due to time and resource limitations, the study was limited to just India and Pakistan. However, given the nature of the investigation the work could be extended to BRICS countries to get interesting insights.

6.1. Policy Implications

Both countries are recommended to devise policies to enhance Human capital development, for this purpose both countries should allocate more funds for the education sector. According to Economic Survey of Pakistan, in 2014-15, Pakistan allocated 0.29% of its GDP, for Research and Development expenditures and according to Ministry Of Science & Technology Government Of India , India allocated 0.69% of its GDP for Research and Development expenditure .While according to WDI statistics , China , the developing neighboring country of both Pakistan and India , allocated 2.02% of its GDP for R & D expenditures in 2014-15.United States of America and Japan spent, 2.75% and 3.39% of their GDP respectively for R& D purposes . Both India and Pakistan are developing countries and therefore are urged to follow the footstep of developed countries.

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