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Human Capital Spillovers, Productivity and Growth in the Manufacturing Sector of Pakistan

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Manufacturing is an important sector of Pakistan's economy. The main focus of this paper is to analyse the major factors of value-added growth and productivity in the manufacturing sector by using Translog Production Technology over the period 1971-72 to 2004-05. The empirical findings show that the contribution of productivity and human capital is around one- third of the total value-added growth in manufacturing sector which is less than the contribution attributed to these factors in developed and many other developing countries. Conventional factors like capital and labour are still the mainstay in the value-added growth of Pakistan's manufacturing sector.

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Keywords: Human Capital Spillovers, Total Factor Productivity, Absolute and Relative Shares

I. INTRODUCTION

Manufacturing sector has been playing an important role in the economy of Pakistan. In 2005-06 its contribution to GDP and employment amounted to 18 percent and 14 percent respectively. It also plays a vital role in exports whose composition over time has changed significantly from primary commodities to manufactures and semi-manufactures with their share in total exports having nearly tripled, from 28 percent in 1972-73 to 79 percent in 2004-05.[1] Development therefore of the manufacturing sector will have far reaching impact on exports, employment prospects, development of agriculture (by providing machinery and other inputs like fertilisers, etc.) and other sectors by bringing technological changes and absorbing technological spillovers from abroad.

This paper aims at measurement of contribution of factor inputs, technological change and technical efficiency to value-added growth in the manufacturing sector together with measurement of total factor productivity (TFP) change index.

The layout of the paper is as follow: a review of literature is presented in Section II. Section III discusses the methodology, variables and data sources. Discussion of empirical findings and comparisons with other relevant findings is given in Section IV. Summary and conclusions with relevant policy suggestions are presented in Section V followed by references.

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[1]*Pakistan Economic Survey 2005-06* and *Labour Force Survey 2005-06*, Government of Pakistan.

II. REVIEW OF LITERATURE

The following review is intended to provide an overview of the broad aspects of topical literature relating to the subject of this paper on a selected basis.

Abramovitz (1956) did an empirical study for the US labour market for the period 1900-1950 and concluded that almost two-third of the increase in labour productivity could not be explained by increase in factor inputs. Solow (1957), Schultz (1964), Ferguson (1965), Hulten (1973), and Kendrick (1973) reported similar results for subsequent periods.

Perelman (1995) did an analysis for eleven OECD countries for the period 1970-1987 and measured technical efficiency, technological progress and total factor productivity (TFP) growth for the manufacturing industries. According to his findings TFP growth was 1.6 percent and technological progress was 1.8 percent during the sample period. He found that the main contributor in Japan's productivity growth in manufacturing was the efficiency factor.

Coe, *et al.* (1997) used data of 77 countries over the period 1971–1990 for measuring technological change and development with spillovers on productivity and growth. They concluded that a developing country can benefit more from the technological progress and innovations occurring in the world and can boost its productivity by importing a larger variety of intermediate products and capital equipments with new technology and innovations.

Kruger (2003) measured TFP for a sample of 87 countries for the period 1960-1990. Technological progress contributed about 66 percent of TFP growth in OECD/EU/G7 economies, while the share of technical efficiency was one third of TFP.

Kumbhakar (2003) used panel data for 450 manufacturing industries in US for the period 1959–92 to measure TFP and technical change. His results show that capital productivity increased by 6.5 percent.

Romer (1986) proposed that development and growth were driven by the accumulation of knowledge. He termed knowledge as a basic form of capital with investment in knowledge and R&D leading to increasing marginal returns of factor inputs. He held that knowledge had a "natural externality" and positive spillovers within and outside the economy.[2] Romer (1990) assumed four basic factors of production in an endogenous growth model: i.e., capital, labour, human capital and an index for the level of technology. According to him, key to growth and sustained development was an adequate stock of human capital.

He and Liu (2006) measured investment-specific technological change and dynamics of skill accumulation for the US for post Second World War period 1949–2000. According to their analysis, US placed great importance on skill accumulation and on job training.[3] Investment-specific technological change and technical efficiency contributed about 62 percent to average output growth per hour over the period.

[2]Knowledge is a non-rival good as knowledge of one thing can simultaneously be used by others without additional cost.

[3]Perli and Sakellaris (1998) estimated that expenditures related to on the job training (OJT) in 1987 were about $165 billion, while total educational expenditure was about $331 billion. These numbers suggest that OJT expenditure may account for as much as half of total educational expenditure in the US.

Kim and Lee (2006) measured TFP, technological change and technical efficiency for 49 countries for the period 1965–1990. Their analysis found that East Asian countries led the world in technical efficiency and productivity growth leading to higher economic growth. For example Korea, Taiwan, Hong Kong and Japan grew at the high rates of 8.51 percent, 8.62 percent, 8.03 percent and 5.74 percent respectively during 1965 to 1990. Technological development, human capital accumulation and technical efficiency were the major contributors in their higher and continuous growth rates during the reference period. Hong Kong, Japan, Taiwan and Korea showed the highest TFP growth rates of 3.85 percent, 3.53 percent, 2.85 percent and 2.18 percent respectively during the period 1965–1990.

Robinson (1971) estimated technological change, technical efficiency and spillovers caused by human resource accumulation for 39 developing countries and found that, on average, the share of productivity in total growth was 15 percent in these countries. This is a much smaller percentage attributable to technological change, technical efficiency and human capital accumulation than that in developed countries which is over 50 percent in most of the cases.

Yanrui (1995) estimated technical efficiency for agriculture and manufacturing sectors of China. According to his estimations, technological change and efficiency contributed about 53 percent in the state industrial sector, 58 percent in the rural industrial sector, and 55 percent in agriculture in the Chinese economy.

Zheng, *et al.* (2003) measured TFP in Chinese state- owned enterprises (SOEs) for the period 1980–1994. Their findings show that technical progress contributed significantly in the TFP growth for Chinese SOEs during the reference period and its annual average growth rate was as high as 10 percent. Technical efficiency ranges between 50 to 80 percent during the reference period. TFP grew at significant rates of 3 percent to 12 percent during 1980–1989, and at 3 percent to 8 percent during 1990–1994. Education was found to play a significant role in technical efficiency.

Ruhul (2006) found that in food manufacturing sector in Bangladesh, efficiency ranged between 60 to 81 percent which could be increased by 19 to 39 percent through human capital accumulation in the form of education and on job training.

Cheema (1978) found high productivity growth rate and significant contribution in the manufacturing sector of Pakistan while Ahmed (1980) who estimated productivity growth for the period 1958–70 found low gains in labour productivity. Kemal (1981) analysed the impact of technological change and technical efficiency for the period 1959-60 to 1969-70. He found overall decreasing returns to scale. Kemal and Ahmed (1992) estimated technological change, efficiency growth and productivity for agriculture and manufacturing as well as for the whole economy of Pakistan, but their studies suffer from certain limitations due to use of various functional forms to get estimates of technical efficiency without determining which form was appropriate for which industry.

Kemal, *et al.* (2002) analysed technological change, technical efficiency and TFP for Pakistan. According to their estimates, TFP grew at a rate of 1.66 percent for the period 1964-65 to 2000-01 and its share in growth of GDP was roughly one-third during the period. TFP in the manufacturing sector showed an average growth of 3.21 percent during 1964-65 to 2000-01 and 4 percent during the sixties mainly through the process of learning by doing coupled with improved export competitiveness.

Khan (1989) measured elasticity of substitutions between inputs, technical progress and returns to scale in the manufacturing sector of Pakistan by using two-level CES production function. He calculated low elasticity between labour, capital and energy and found that the manufacturing sector was exhibiting decreasing returns to scale having experienced disembodied technical progress at the rate of 3.7 percent per annum.

Mahmood (1989) used Translog Cost Function to estimate derived demand for factors in the large-scale manufacturing sector of Pakistan. The estimations found that capital and energy were complementary, and labour, capital and energy were substitutes. The lifting of any subsidy on energy and capital would tend to reduce the energy and capital intensity and, in turn, would increase the labour-intensity in the large scale manufacturing sector of Pakistan. According to his results, adoption of such a policy could help in reducing the burden of unemployment.

Mahmood (1992) further used Translog Cost Function to estimate the effects of change in government's pricing policy and external price shocks on factors demand for the industrial sector of Pakistan. According to this study, the skills of the labour force improve with technological advancements and growth in income. He found that production and non-production workers were high substitutes in the pre-energy shock period and had become marginally stronger substitutes in the post-energy shock period.

Ali and Hamid (1996) measured technological change, technical efficiency, productivity and their impact on input demand for agriculture and manufacturing in Pakistan. They found that major contributors to value-added growth in both sectors were primarily traditional factors of production.

Tariq, *et al.* (1997) estimated factor substitution, technical efficiency and employment generation in large scale manufacturing industries of Pakistan and found that technological change was capital intensive and labour saving.

Mahmood and Siddiqui (2000) measured TFP for manufacturing in Pakistan over the period 1972 to 1997. They found that increased expenditure on R&D, growth of scientific and technical manpower and growth in knowledge and human capital had a significantly positive impact on TFP growth in manufacturing. Knowledge and human capital were found to explain 30 percent and 18 percent of the variance in TFP, respectively. They also found positive and significant impact of openness and trade liberalisation on TFP.

This review of relevant literature reveals that human capital, technological change and technical efficiency are important sources of growth in the developed countries but these factors have exhibited less importance in developing countries like Pakistan. As a result, only a few studies on human capital accumulation, technological progress and technical efficiency are available especially on Pakistan, and those few also suffer from certain analytical limitations using e.g., Hicks neutral technological change assuming that technological change is happening at a constant rate. In the present research, technological change, technical efficiency, and productivity growth are measured for the manufacturing sector of Pakistan. Besides this, the study also endeavours to measure the major determinants of growth and productivity and the absolute and relative shares of these determinants of value-added growth and TFP in the manufacturing sector. Empirical analysis with international comparisons will be made in this background with related policy implications and conclusions.

III. METHODOLOGY

The following factors are assumed to be the major contributors to value-added growth in manufacturing:

$$Y = f(A, L, K, H) \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (1)$$

Where

Y = Value-added growth in manufacturing.
L = Labour employed in manufacturing.
K = Capital stock in manufacturing.
A = Level of technology.
H = Human resources in manufacturing.[4]

Labour and capital have since long been considered as among the most important factors of production in the literature. The more recent studies like Romer (1986, 1990), He and Liu (2006) and Yanuri (2006), etc., have also used the level of technology and human capital as important factors in the analysis of total factor productivity. This paper also assumes both of these factors as key contributors to value-added growth in manufacturing along with traditional factors of labour and capital. In order to measure the major factors contributing to value-added growth, technological change and technical efficiency (which in-builds overtime due to human capital formation), the Translog production function for labour, capital, human capital and technology can be written as:

$$\ln Y_{it} = \alpha_o + \lambda t + \alpha_k \ln K_{it} + \alpha_L \ln L_{it} + \alpha_H \ln H_{it} + (1/2)\,\alpha_{kk}\,(\ln K_{it})^2 + (1/2)\,\alpha_{LL}\,(\ln L_{it})^2 + (1/2)\,\alpha_{HH}(\ln H_{it})^2 + \alpha_{KL}\,(\ln K_{it} \ln L_{it}) + \alpha_{KH}\,(\ln K_{it} \ln H_{it}) + \alpha_{LH}\,(\ln L_{it} \ln H_{it}) + u_{it} \quad \ldots \quad (2)$$

The following homogeneity constraints are implied in the Translog production function:

$$(\alpha_{LK} = \alpha_{KL},\ \alpha_{HK} = \alpha_{KH},\ \alpha_{HL} = \alpha_{LH})$$

$$\sum(\alpha_K, \alpha_L, \alpha_H) = 1$$

$$\alpha_{KK} + \alpha_{KL} + \alpha_{KH} = 0$$

$$\alpha_{KL} + \alpha_{LL} + \alpha_{LH} = 0$$

$$\alpha_{KH} + \alpha_{LH} + \alpha_{HH} = 0$$

Subject to these homogeneity constraints, the Translog production function will be estimated in conjunction with a cost share function with cross-equation restrictions imposed, a method suggested by Berndt and Christensen (1973). Labour, capital and human capital cost share equations are derived as:

$$CS_L = \partial \ln Y / \partial \ln L = \alpha_L + \alpha_{LL} \ln L + \alpha_{LK} \ln K + \alpha_{LH} \ln H + u_{it} \quad \ldots \quad \ldots \quad (3)$$

$$CS_K = \partial \ln Y / \partial \ln K = \alpha_K + \alpha_{KK} \ln K + \alpha_{KL} \ln L + \alpha_{KH} \ln H + u_{it} \quad \ldots \quad \ldots \quad (4)$$

$$CS_H = \partial \ln Y / \partial \ln H = \alpha_H + \alpha_{HH} \ln H + \alpha_{HL} \ln L + \alpha_{HK} \ln K + u_{it} \quad \ldots \quad \ldots \quad (5)$$

[4]Human resource development activities like education, professional and vocational training, R&D activities etc.

Where

CS_L, CS_K, CS_H are the labour, capital and human capital shares of total cost, respectively.[5]

The cost share equations will be estimated by applying "Seemingly Unrelated Regressions" [Zellner (1962)]. The Translog production function can also be estimated by using a Stochastic Frontier Approach (SFA), adopting a more flexible approach for restriction conditions.[6]

Following Baltagi and Griffin (1988) and Kumbhakar (2003), single output Translog cost function in the form of time trend model is written as:

$$lnC_{it} = \beta_0 + \Sigma_j \beta_j \, ln\, P_{jit} + \beta_y \, ln\, Y_{it} + \beta_t t + ½ \{\Sigma_j\Sigma_k \beta_{jk} lnP_{jit} \; lnP_{kit} + \beta_{yy} (lnY_{it})^2 + \beta_{tt}t^2 + \Sigma_j\beta_{jy}lnP_{jit}lnY_{it} + \Sigma_j\beta_{jt}lnP_{jit}t + \beta_{yt} \, lnY_{it} \, t \quad \ldots \quad \ldots \quad (6)$$

Where

$$\beta_{jk} = \beta_{kj}, \; \Sigma_j \beta_j = 1, \; \Sigma_j \beta_{jk} = 0, \; \Sigma_j \beta_{jy} = 0, \text{ and } \Sigma_j \beta_{jt} = 0$$

The first restriction is due to symmetry; the rest due to the fact that cost function is homogenous of degree one in the input prices.
where

C = total cost
Y = output
P_j = jth input price

From the Translog cost function given in Equation 9, technological change is measured as follows (technological change being defined as the percentage change in the total cost over time *ceteris paribus):*

$$-\partial\, lnC_{it} / \partial t = -[\, \beta_t + \beta_{tt}t + \Sigma_j \beta_{jt} \, lnP_{jit} + \beta_{yt} \, lnY_{it}] \quad \ldots \quad \ldots \quad \ldots \quad (7)$$

Measurement of Total Factor Productivity (TFP) Change Index

The TFP change index is defined as the difference between rate of change of output and rate of change of inputs:

$$TFP^{\bullet\cdot} = y^{\bullet\cdot} - x^{\bullet} \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (8)$$

Where

$TEP^{\bullet}$ $TFP^{\cdot}$ = total factor productivity change index
$y^{\bullet\cdot}$ = rate of change of output
$x^{\bullet\cdot}$ = rate of change of inputs

[5]The coefficients of Translog function can also be estimated from Equation (2) by using OLS technique. However, there may occur multicollinearity problem (as labour and capital increase with a specific ratio which results in the existence of a relationship between two explanatory variables and this specific relationship causes multicollinearity problem). In order to overcome this problem we have estimated cost share equations by applying SURE. Parameters of variable H can be estimated from cost share of labour and cost share of capital by using equality constraints.

[6]Stochastic Frontier Approach (SFA) was introduced by Aigner, *et al.* (1977) and Meeusen and Van den Broeck (1977).

TFP growth can be estimated by subtracting the contribution of measured inputs growth from output growth.

Measurement of Absolute and Relative Contribution

The method for calculation of absolute contribution was introduced by Hicks (1979) and calculation of relative contribution by Hadjimichael, *et al.* (1995). The absolute share of any factor of production towards growth can be found by multiplying the estimated coefficient of the explanatory variable by standard deviation of the respective explanatory variable. The relative contribution for each independent variable can be measured by dividing its estimated absolute share by the standard deviation of the dependent variable. The relative share of variables will be unit free.

Data and Variables Description

The above model for the measurement of major factors contributing to value-added growth and productivity, technological change, technical efficiency and relative and absolute share of factors in the manufacturing sector of Pakistan is based on the following variables and data sources (data series covers the period from 1972-73 to 2006-07). All data is converted on 1980-81 constant market prices. Real value-added in manufacturing sector on constant market prices is used and data sources for value-added include the *Pakistan Economic Survey* (1990-91 and 2007-08) and Pakistan (1999) *50 Years of Pakistan in Statistics*: Volume I–IV. The number of employed workers in manufacturing is used as a labour input and data on the variable is taken from *Pakistan Economic Survey* (1990-91 and 2007-08) and Pakistan (1999) *50 Years of Pakistan in Statistics*: Volume I–IV. Enrolment in the secondary, higher and other categories like professional, vocational colleges, universities and other institutes as a ratio to total employed labour force in the manufacturing is used as a proxy to measure the impact of human capital[7] in the manufacturing; data sources include *Annual Education Statistics* (Various Issues); *Pakistan Statistical Years Book* (Various Issues); *Pakistan Economic Survey* (1990-91 and 2007-08); Pakistan (1999) *50 Years of Pakistan in Statistics*: Volume I-IV; *Human Development Report*, UNDP (2007) and *World Development Report* (2007).

Capital Stock

Capital stock is measured by using perpetual inventory method as per following equation:

$$K_t = I_t + (1 - \varphi)K_{t-1} \qquad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \qquad (9)$$

Where

K_t = Capital Stock in current year.

K_{t-1} = Capital Stock in previous year.

I_t = Current Year Investment or Gross Fixed Capital Formation.

φ = Depreciation rate.

[7]Five years lag enrolment was used for secondary education and four years lag for enrolment in other categories like professional and vocational institutions and enrolment in universities etc.

For estimating the initial capital stock $K(0)$, the method used by Nehru and Dhareshwar (1993) and Khan (2006) is being followed. The capital stock series will be generated in the following way:

$$K_t = I_t + (1 - \varphi)^t K(0) + \sum I_{t-i} (1 - \varphi)^t \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (10)$$

Where

I = o to t–1

$K(0)$ = initial capital stock in year zero.

Nehru and Dhareshwar (1993) and Khan (2006) used a modified Harberger (1978) method to estimate $K(0)$. The value of investment for the first year is estimated by way of a linear regression equation of the log of investment against time. The estimated value of investment for the base or zero year is used to calculate $K(0)$ as per following equation:

$$K(0) = I_t / (gr + \varphi) \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (11)$$

Where

gr = Compound value-added growth rate

φ = Depreciation rate

Various depreciation rates have been used in empirical studies. Here 5 percent capital depreciation rate is assumed. Several other studies used 4 percent depreciation rate e.g., Nehru and Dhareshwar (1993), Collins and Bosworth (1997), Khan (2006), etc.

IV. EMPIRICAL FINDINGS

The measurement of major determinants of value-added growth and the contribution of factor inputs, technological change and technical efficiency to value-added growth in the manufacturing sector of Pakistan is presented in this section. It also includes calculation of relative and absolute shares of factor inputs in the value-added and the measurement of total factor productivity change index (TFPI).

Translog Production Function Estimates for the Manufacturing Sector

Table 1 presents the estimated results for Translog Production Function in manufacturing. Zellener's Seemingly Unrelated Regression Equations (SURE) technique has been used to find the estimations. All the results are according to theoretical expectations. The estimated coefficient for technology is 0.02, a positive contribution towards the value-added growth in manufacturing. The estimated t-value shows that the coefficient is significant at 1 percent level of significance. The estimated coefficient for capital stock (K) is 0.65 and has a 1 percent level of significance. The estimated coefficient for labour and human capital are 0.15 and 0.20 respectively.[8] The contribution of factor inputs, technological change and technical efficiency to the value added in manufacturing is presented in Table 2. The estimated share for capital (K), Labour (L) and Human Capital (HK) are taken from Translog production function estimations presented in Table 1 and these are 0.65, 0.15 and 0.20 respectively. The weighted

[8]The value of coefficient for human capital is calculated from the constraints as explained in methodology.

Table 1

Translog Production Function Estimates for the Manufacturing Sector (1971-72 to 2000-01)

Independent Variables	Dependent Variable Value-added
Constant	3.52^{***}
	(77.68)
Λ	0.02^{***}
	(7.95)
$\ln K_{it}$	0.650^{***}
	(2.82)
$\ln L_{it}$	0.15
	(0.84)
$\ln H_{it}$	0.20^{e}
$(\ln K_{it})^2$	0.023
	(1.18)
$(\ln L_{it})^2$	–0.0008
	(0.60)
$(\ln H_{it})^2$	0.0038^{e}
lnL*lnK	–0.0055
	(0.38)
lnL*lnH	–0.0031
	(0.22)
lnK*lnH	–0.0007
	(0.04)
R^2	0.93
Adj-R^2	0.92
SER	0.005
DW- stat	1.66
N	30

Notes: Values in parenthesis are *t*-ratios.
*** Significant at 1 percent level.
** Significant at 5 percent level.
* Significant at 10 percent level.

The Method of Estimation is Zellner's Seemingly . Unrelated Regression Technique (SURE).
e= Values of parameters derived from constraints .

Where:
SER= Standard Error of Regression;
DW-stat= Durbin-Watson stat; N= Number of Observations;
K=Capital Stock; L= Labour Employed; H= Human Capital

Table 2

The Contribution of Factor Inputs, Technological Change and Technical Efficiency (TFP) to Value-added Growth in Manufacturing Sector (Calculated from Translog Production Function Estimates in Table 1)

Variables	Shares Estimations Based on Translog PF
Value-added Growth Rate	6.60
Labour Growth Rate	3.17
Capital Growth Rate	5.89
HK Growth Rate	5.02
Share of Capital in Value-added	0.65
Share of Labour in Value-added	0.15
Share of HK in Value-added	0.20
Weighted Capital Growth Rate	3.83
Weighted Labour Growth Rate	0.48
Weighted HK Growth Rate	1.00
Total Factor Input Growth Share in Value-added Growth	5.31
Technological and Technical Growth (TFP) Share in Value-added Growth	1.29
Major Determinants of Growth as Percentage of Value-added Growth	
Capital Contribution	58
Labour Contribution	07
HK Contribution	15
Total Factor Inputs Contribution	80
Technological Change and Technical Efficiency (TFP) Contribution	20
Total	**100**
Share of HK, Technological Change and Technical Efficiency	**35**

Source: Estimations is Table 1.

growth rates for K, L and HK are measured by multiplying average growth rates of these variables by their respective estimated coefficients in Table 1. The calculated weighted growth rates for K, L and HK are 3.83 percent, 0.48 percent and 1.00 percent respectively. The share of total factor inputs growth in value-added of manufacturing accounted for 5.31 percent. The share of technological change and technical efficiency in value-added is the difference between the average value-added growth (6.6 percent) and total factor inputs weighted growth rates (5.31 percent). This estimated TFP contribution accounted for 1.29 percent. The estimated shares as percentage of total value-added growth in manufacturing show that capital stock contributes the maximum (58 percent) while labour and human capital contributes 07 percent and 15 percent respectively. One reason for this insignificant role of human capital is that technical and vocational training is given low priority and is not of that quality in Pakistan which enables human capital to bring new significant technological changes and can compete internationally and absorb technological spillovers from the advanced world. The total contribution of input factors accounts for 80 percent. The contribution of technological change and technical efficiency (TFP) is 20 percent and the contribution of TFP and human capital in value-added growth rate of manufacturing accounts for 35 percent.

Measurement of Absolute and Relative Contribution to Manufacturing Value-added and Calculation of TFP Change Index

The estimated results are depicted in Tables 3 and 4 respectively. The absolute shares for capital, labour and human capital are 0.398, 0.039 and 0.076 respectively. The relative shares for these explanatory variables follow the same pattern which for capital, labour and human capital are 0.621, 0.061 and 0.119 respectively. The measurement of absolute and relative shares show that value-added growth in manufacturing depends more on physical factors of production and less on human capital.

Table 3

Absolute and Relative Contributions of Major Determinants of Growth to Manufacturing Value-added

Variables	Estimated Standard Deviations	Estimated Coefficients	Absolute Contribution to Value-added	Relative Contribution to Value-added
Ln(K)	0.612	0.650	0.398	0.621
Ln(L)	0.260	0.150	0.039	0.061
Ln(H)	0.381	0.200	0.076	0.119
SD of Dependent Variable (Y)	0.641	–	–	–

Where:

Y= Value-added in Manufacturing;
K= Capital Stock in Manufacturing;
L = Labour Employed in Manufacturing;
HK= Human Capital; and
SD= Standard Deviation; Estimated co-efficients are taken from Table 1.

Table 4 presents the calculations for total factor productivity (TFP) change index in the manufacturing sector from the estimations based on Translog production function given in Table 1. Column (2) in Table 4 shows overtime rate of change of value-added in the manufacturing sector, while columns (3), (4) and (5) show overtime weighted rate of change of inputs i.e. weighted rate of change in capital, labour and human capital. The aggregated weighted rate of change of manufacturing inputs is presented in column (6). The difference between column (2) and column (6) i.e. difference between rate of change of value-added and the rate of change of aggregated weighted inputs is given in column (7) which is the overtime TFP change. The three years moving average growth counts for the sample period are measured at 0.0644, 0.0496 and 0.0147 for value-added, weighted aggregated inputs and TFP respectively. The last column in Table 4 shows the TFP Index which has changed from 100 in 1972-73 to 147.11 in 2004-05.

Table 4

Manufacturing TFP Change Index (1972-73 to 2004-05)
Based on Translog PF Estimates (3-Years Moving Average)

Year	Y•	K•	L•	HK•	Aggregated Inputs	TFP•	TFPI
1971-72							
1972-73							**100.00**
1973-74	0.0501	0.0232	0.0157	0.0041	0.0430	0.0071	**100.71**
1974-75	0.0269	0.0233	0.0422	0.0041	0.0697	–0.0428	**96.43**
1975-76	0.0125	0.0464	0.0110	0.0082	0.0656	–0.0531	**91.12**
1976-77	0.0452	0.0713	0.0117	0.0126	0.0957	–0.0504	**86.08**
1977-78	0.0675	0.0880	0.0119	0.0156	0.1154	–0.0479	**81.29**
1978-79	0.0949	0.0858	0.0079	0.0152	0.1089	–0.0140	**79.89**
1979-80	0.0970	0.0781	0.0043	0.0138	0.0963	0.0008	**79.96**
1980-81	0.1166	0.0621	0.0004	0.0110	0.0735	0.0431	**84.28**
1981-82	0.1031	0.0484	0.0009	0.0086	0.0578	0.0453	**88.81**
1982-83	0.0935	0.0410	0.0032	0.0073	0.0515	0.0420	**93.01**
1983-84	0.0769	0.0417	0.0052	0.0074	0.0543	0.0227	**95.28**
1984-85	0.0783	0.0426	0.0016	0.0075	0.0518	0.0265	**97.93**
1985-86	0.0771	0.0424	0.0087	0.0075	0.0585	0.0185	**99.78**
1986-87	0.0841	0.0340	–0.0004	0.0060	0.0396	0.0445	**104.24**
1987-88	0.0704	0.0259	0.0043	0.0046	0.0348	0.0356	**107.80**
1988-89	0.0643	0.0200	–0.0031	0.0035	0.0205	0.0438	**112.18**
1989-90	0.0516	0.0225	–0.0004	0.0040	0.0261	0.0255	**114.73**
1990-91	0.0673	0.0268	0.0008	0.0047	0.0323	0.0350	**118.23**
1991-92	0.0654	0.0355	0.0012	0.0063	0.0430	0.0225	**120.48**
1992-93	0.0637	0.0400	–0.0085	0.0071	0.0386	0.0251	**122.99**
1993-94	0.0478	0.0426	–0.0092	0.0075	0.0410	0.0068	**123.67**
1994-95	0.0461	0.0309	–0.0132	0.0055	0.0233	0.0229	**125.96**
1995-96	0.0322	0.0237	0.0149	0.0042	0.0428	–0.0106	**124.90**
1996-97	0.0143	0.0172	0.0067	0.0030	0.0269	–0.0126	**123.64**
1997-98	0.0112	0.0192	0.0071	0.0034	0.0297	–0.0185	**121.79**
1998-99	0.0128	0.0186	0.0074	0.0033	0.0293	–0.0165	**120.14**
1999-00	0.0464	0.0177	0.0114	0.0031	0.0322	0.0142	**121.56**
2000-01	0.0505	0.0148	0.0332	0.0026	0.0505	–0.0001	**121.55**
2001-02	0.0698	0.0142	0.0188	0.0025	0.0355	0.0342	**124.97**
2002-03	0.0908	0.0169	0.0219	0.0030	0.0418	0.0490	**129.87**
2003-04	0.1156	0.0194	0.0041	0.0034	0.0270	0.0887	**138.74**
2004-05	0.1151	0.0206	0.0072	0.0036	0.0314	0.0837	**147.11**
Average	**0.0644**	**0.0361**	**0.0072**	**0.0064**	**0.0496**	**0.0147**	

Notes: Y= Manufacturing Value-added; K= Capital Stock;
L= Labour Employed; HK= Human Capital;
TFP= Total Factor Productivity;
TFPI= Total Factor Productivity Index;
Where over dotes show the change over time;
Growth rates for K, L and HK are weighted growth rates;
Weights are taken from estimated Translog Production Function in Table 1.

V. SUMMARY AND CONCLUSIONS

The findings of this study show that conventional factors of production are still the mainstay for value-added growth in manufacturing, contributing about 65 percent of the total value-added growth, while the shares of human capital, technological changes and technical efficiency were measured at 14 percent and 22 percent respectively. TFP along with human capital was contributing around 35 percent to the total growth in the manufacturing sector. This is significant but not up to the required level as in case of developed and in some developing countries its share has been reported at over 50 percent. Based on the empirical findings, the following recommendations and conclusions may be derived:

- Human capital should be given top priority by allocating more resources to education, training, health and to other measures along with physical factors so that human capital can properly be used for enhancing growth of the economy.
- Education policies should be devised according to the requirement of the economy and technical, vocational and professional education must be given top priority as the manufacturing sector has very high need for technical and vocational labour force.
- As openness of the economy is important for raising value-added growth and attracting more technological innovations and spillovers, there is need to search for new markets for Pakistani products through international publicity and interaction with other countries, especially with less developed and neighbouring countries.

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