Total Factor Productivity and Economic Growth of Pakistan: A Time Series Analysis

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Abstract

The investigation of contribution of total factor productivity to economic-growth for Pakistan for period 1978-2019 was objective of current article. Johanson and Jusilies (1988, 1995) Co integration technique has been used to estimate the growth equation. Using growth accounting approach for estimation of total factor productivity. Labour force, physical-capital, human-capital and trade openness used as a set of control variables. To study the serial correlation we have use LM test. Wald test have been use as a coefficient diagnostic that have reported the existence of the short run relations ship also among the variable(s). The Granger-Causality test measure Causality of variables that shows some of variables had a Bi-directional causality and some of them have uni-directional causality. The study used collected data from world development indicators. In the particular, study found that there is long run relationship in TFP and Economic-growth as well as in short-run. This study is (i) among one of very few country specific investigations exploring Total Factor productivity (TFP) and growth nexus (ii) Using an advanced time series technique on most recent data set.

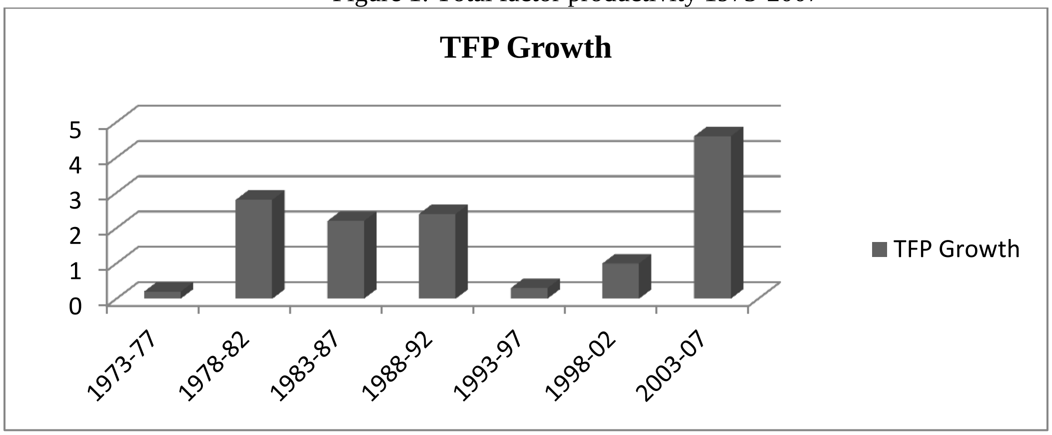
Keywords: *Economic Growth, Cointegration, human capital, trade openness, Granger Causality, Pakistan.*

Introduction

One of the prevalent discussions of the all economies is to identify that how much of total output is produced by the human and physical capital and how much of output produced by the other factors like institutions and adopted technology. In economic literature there is a little suspicion about the valuable influence of higher human and physical capital on the economic growth, most of economist claimed that the continuous high economic growth depend upon the sustained technology and as well as on institutional growth in the economy. Based upon the assumption of perfect competition and constant returns to scale. There is a lot of discussion about interesting question of sources of economic growth, chief amongst them is Total Factor Productivity.

Total Factor Productivity (TFP) is the share of output not explained by amount of inputs used in production. As such, its level is determined by how efficiently and intensely the inputs are utilized in production. Physical-capital, human-capital, and technology are sources of TFP. TFP growth is usually measured by Solow residual, as was first discussed by Solow (1956-58) and modified production function in Hicks-Netural form: *Y= A. F (K, L).* It expresses that the ratio of marginal product remains same for a given capital and labor ratio. According to Kemal *et al.*, (2002), practically one-third of the growth in GDP can be accounted for by growth in productivity. Similarly, by (Groskopf and Self, 2006) growth based on factor accumulation was not as strong as based on human capital. Furthermore, productivity estimations are familiar for consequence of business cycles and inflation. So, it can be a reliable source for policy makers (Kong and Tongzon, 2006). Figure 1 below shows that in 1978-1982 and 2003-2007 Pakistan attained higher level of TFP growth particularly in 2007.

Figure 1: Total factor productivity 1973-2007



Keeping in view importance role of TFP in growth we formulate our objectives, research question(s) and hypothesis respectively as follows;

To examine the influence of TFP in economic growth of Pakistan and suggest suitable policy implications.
Whether or not Total Factor Productivity has significantly affected the economic growth of Pakistan?
Ho: Total Factor Productivity has significant effect on economic growth of Pakistan.

There are a lot of studies which had used total factor productivity analysis for different data set. Most of the Industrial studies include Baldwin and Rafiquzzaman (1994), Rao and Shandre (1998), Bjurek and Durevall (2000), Fare *et al.*, (2001), Mahadevan (2002), Idris and Rehmah (2006), Diaz and Sanchez (2008). In economic literature the role of productivity growth in improving the economic growth is very crucial. In neo-classical growth accounting setup, the total output growth is a return of, the growth of inputs accumulation and the growth of productivity or efficiency. Consequently, for existing combination of factor inputs (capital, land and labor), and the changes in the production function are enthused by developments in the efficiency. The technological progress is being considered as an exogenous procedure in the neoclassical framework, for instance the Ramsay Optimal Growth Models (1928) and Samuelson Overlapping Generation Models, (1958) Slow Growth Model (1956), and their supporters. These all models have been dared by the endogenous growth thinkers, who assume that the technological process is an endogenous process in the growth and can be estimated as TFP. The endogenous technological procedure permits government strategies to shake technological process which in turn will be imitated in TFP and hence in growth. These policies have emotional impact on TFP through human capital endowments of employed labor force, given that better physical infrastructure and other assistance to include technology in the production process. The productivity differences are also important for policymakers because the TFP is the key source of economic growth. The productivity change is usually accrued due to two factors. First one is in the production process the adoption of technical innovation, like other developing countries Pakistan also adopted from advanced countries, and the other is ability of firms to rise production with given technology and inputs. A productivity evaluation between diverse sectors can also lead to cause of industrial growth and will also help in allocation of resources to different sectors (Bukhari *et al* 2005). There is scarce work that tried to describe the factor of TFP growth. Certain other studies like Grilick (2000) have include side discussion of determinants of TFP in Pakistan Pasha *et al.*, (2002) Sabir and Ahmed (2003). Husna *et al.*, (2009) examines the influence of foreign ownership on TFP for food and tobacco and financial business sectors of Pakistan. Sadia *et al.*, (2010) practically investigated the association among TFP and Trade liberalization. The Major problem of the studies relating to Pakistan is their incapability of addressing the TFP and Economic growth. All the studies in recent decade evaluate the TFP growth in small scale and most of base on large scale manufacturing industries. These studies cannot evaluate TFP as the key element of long-run economic growth in case of Pakistan. There are number of studies that capture the total factor productivity growth and efficiency in Agriculture sector (Azam, 2007), But in case of Pakistan now agriculture sector is no longer the key producing sector. This study enhances to the current estimates for Pakistan by calculating TFP on the first stage through growth accounting process, and on the next stage tries to analysis the relationship among economic growth and TFP in long run with co-integration.

This paper is structured into five sections, starts with an introduction section followed by the literature review, methodology and data, results and discussions, and finally conclusion section.

Literature Review

This review describes many factors that have relationship with the of TFP growth. Some of these are, infrastructure, human capital (health and education), financial development, openness, competition, imports, geography and capital deepening. In the industrial countries Innovations and R&D had been considered essential for TFP growth, as against the case of less developing countries. Sectoral and sub-sectorial analysis of economy also show long run nexus among output and TFP (Khan *et al.*, 2019). There are two different opinions about the economic growth. One is the “accumulationist view”. Accumulation of resources related with the traditional growth. The other one, called the “revisionist” a response to the traditional, oppose accumulation and argues efficiency behind economic growth like Asian tigers miracle (Han, 2003).

Solow (1956) and Rodriguez-Clare (1997) confirmed that technology is the only thing that may create essential cross-country variances in term of income per capita. Hall and Jones (1999) concluded that, TFP is very important for sustained economic growth process. In similar way, some studies have emphasized the need for inclusive growth to experience smooth growth in developing countries through fiscal factors, human capital and capital formation (Anwar *et al.*, 2019; Aslam *et al.*, 2019). According to “Atkinson and Stiglitz (1969) TFP is insufficient to few sectors of the economy. According to Edwards, (1993, 1997); Grossman and Helpman, (1990, 1991)”; (Demurger, 2000) a significant relationship between trade openness and total factor productivity growth was good source for growth. Conversely, according to Young (1992); “Kim and Lau (1994); Ben and Spiegel (1994)”; Young (1995) TFP growth was result of growth of factor accumulation. But the studies like Romer, and Weil (1992) Islam (1995); Miller and Upadhya (2000) and Rauf *et al.,* (2017) opinioned human capital has significant effect on total factor productivity.

Studies like Fare *et al., (*1995); Jones and Williams (1998); and Comin (2002) concluded that R&D has valuable impacts on TFP. Mayer (2001) argued that trade based on imports in such a way by introducing foreign technology into national production that leads to significance effect on TFP while some conclude that De-industrialization had negative effects for growth and development through lower TFP (Khan *et al.*, 2018). There is significant relationship between TFP growth and international trade (Fatima *et al.*, 2003).

Chanda and Dalsgaard (2003) argued a correlation among TFP and institutions because the intuitions usually regulate the agricultural as well as non-agricultural structure of the country. While Fue (2005) established that productive domestic market and neutral outward sloping policy is essential for exports to produce valuable influence on growth of TFP. Moreover, foreign direct investment has vital role in growth of TFP (Khan, 2006).

Comin, *et al.*, (2006) identified cross-country differences in physical capital could determine the cross-country differences in TFP. Small and medium size firms were more efficient than large (Diaz and Sanchez, 2008). According to Azam (2009) findings of Sectoral TFP analysis suggested that Pakistan has higher average growth rates in comparison of other developing and regional countries but lies below the East Asian Countries.

Recent studies have added different aspects that effect the growth through increasing total factor productivity. Literature survey evidenced the need of exploring TFP and growth nexus further as it remained a major and significant source of growth and development in most of developed countries of the world

Methodology and Data

Empirical model testing starts following Solow and Swan (1956) while TFP is assessed through the remaining term in the production function.

$$Y(t) = F\big(K(t), L(t), A(t)\big) \quad (1)$$

Taking aggregate production function in neoclassical form to estimate the growth of TFP in growth accounting-framework is given as follows:

$$Y_t = F(K_t, L_t, t) \quad (2)$$

From the equation above, Y_t is output K_t is capital and L_t is labor input in physical units and t shows the time in production function. Constant returns to scale are assumed by the function F over time, technical changes shift the function in above model. In economics these changes are known as growth in total factor productivity (GTFP). This production function given in equation (2) now can be written in Hicks-neutral form as:

$$Y_t = A(t)F(K_t, L_t) \quad (3)$$

More inputs mean more output implying marginal product of labour (MPL) and the marginal product of capital (MPK) are both positive. While output (Y) depends on inputs and level of technology (A) in above equation.

So, following base line model will be used for estimating the relationship among TPF and economic growth of Pakistan.

$$Y_t = \beta_0 + \beta_1 TFP_t + \beta_2 X_{it} + \varepsilon_t \quad (4)$$

Where, Y_t is output, while TFP_t represents total factor productivity and X_{it} is the set of control variables including labour force, physical capital, human capital and trade openness. $\beta's$ are parameters of interest to be estimated. Gross fixed capital formulation used as proxy of physical capital and secondary school enrollment as the proxy of human-capital respectively. So, the model to be estimated becomes,

$$Y_t = \beta_0 TFP_t + \beta_1 LF_t + \beta_2 TO_t + \beta_3 SE_t + \beta_4 GFCF_t + \varepsilon_t \quad (5)$$

Data and Construction of Variables

For empirical analysis, present study utilized time series data from 1970 to 2013 obtained from World Development Indicator (WDI). All variables are in real term. Variables to be estimated and their definitions are given in the table below.

Table 1: Variables and definitions

Variable	Description	Measurement
Y_t	Real Gross Domestic Product	Annual percent
TFP_t	Total Factor Productivity	--------
LF_t	Labour Force	Millions(LCU)
TO_t	Trade Openness	Percentage of GDP
SE_t	Secondary School Enrollment Proxy For Human Capital	---------
$GFCF_t$	Gross Fixed Capital Formulation Proxy For Physical Capital	Millions(LCU)

Source: World Bank, World Development Indicators. LCU denotes local currency units

Econometric Methodology

Unit Root Testing

If "variables in the regression model are non-stationary then the standard t-ratios will not follow t-distribution. Time series data has non-stationarity problem, therefore testing for stationarity of data is a pre-requisite as first stage. There are various techniques used to investigate the presence or absence of unit root, present study will utilize Augmented Dickey Fuller (ADF)" test.

Augmented Dickey Fuller Test

Following equations show Augmented Dickey Fuller (ADF) unit root test.

Without "constant and trend; $X_t = \sigma X_{t-1} + \varepsilon_t$ (6)
With constant and no trend; $X_t = \alpha + \sigma X_{t-1} + \varepsilon_t$ (7)
With constant and trend; $X_t = \alpha + \sigma X_{t-1} + \beta T + \varepsilon_t$ (8)
Where X_t is related time-series, α is constant (intercept), T is time trend and ε_t is disturbance.

Transforming above equations in difference by subtracting X_{t-1} from both sides.

Without constant and trend; $\Delta X_t = \pi X_{t-1} + \varepsilon_t$ (9)
With constant and no trend; $\Delta X_t = \alpha + \pi X_{t-1} + \varepsilon_t$ (10)
With constant and trend; $\Delta X_t = \alpha + \pi X_{t-1} + \beta T + \varepsilon_t$ (11)

Where $\Delta X_t = X_t - X_{t-1}$ and π = σ – 1. The null hypothesis is that variable has unit root against alternative of no unit root in the series".

Vector Auto Regression (VAR)

To release linear interdependencies among time series data this study incorporates Vector Auto Regression (VAR). It simplifies the auto regression models by permitting more than one evolving variables in the model. Another simplicity of VAR model is that it does not need as much material about forces inducing a variable as structural models do with simultaneous equations.

Johansen Test of Co-Integration

Present study used the Johansson and Juselius test of co-integration (1990) that is constructed on Vector Error Correction Model (VECM). Because of its advantages on other procedures such as Engle and Granger (1987) and Auto Regressive Distributed Lag Model (ARDLM) we prefer this technique in our analysis. The two series in Johanson procedure are supposed to be co-integrated when their linear combination of I (1) become I(0). Co-integration technique also helps us in finding general stochastic trend as well as long-run relationship between the variables. It is also useful in forecasting long run and separates short run. In co-integration it is assumed that variables are endogenous. Secondly, it is based on same order of integration. The estimation of long run relationship is next step of Johanson co-integration test. The equation of Johansen technique is as follows:

$$\Delta Y_t = \delta + \sum_{i=1}^{k-1} \Gamma_i \, \Delta Y_{t-i} + \prod Y_{t-k} + \varepsilon_t \qquad (12)$$

Where, Y is vector of variables column, Γ and Π representing coefficient metrics, Δ represents change operator, k represents lag length, δ represents constant and ε_t the error term. To analyze whether long run relationship exists among variables Johanson co-integration technique presents two steps. These steps are as under:

Maximum Eigen Values

$$\lambda_{max}\,(r, r+1) = -T ln(1 - \hat{\lambda}_{r+1}) \qquad (13)$$

Another is

Trace Test

$$\lambda_{trace}(r) = -T \sum_{i=r+1}^{n} \ln(1 - \hat{\lambda}_{r+1}) \qquad (14)$$

Where,

$\hat{\lambda}_i$ is “the estimated value characteristics roots. T is total number of observations and r is number of Co-integration vectors.

To catch up with the number of co-integration vectors trace-test and maximum-Eigen-value test were performed. For trace-test, null hypothesis is that there happens maximum “r” co-integrating vectors for example $(r = 0, 1, 2, 3, 4, 5, 6, \ldots)$ and for maximum Eigen value, the null hypothesis is tested against its alternative hypothesis.

Error Correction Model (ECM)

According to Granger-representative-theorem (GRT) data effective error-correction-representation always present in series of variables; if Co-integration of variable are found in order I (1). Granger (1987) stated that error-correction-model would be built, likewise once Co-integration established between the variables in VAR leads to evaluate and specify that ECM which counting error correction term that used to investigate dynamics of model. The speed of adjustment of instability in equilibrium of long-run is influenced by size of error-correction term”. For analysis, Error-Correction-equations are given as under;

$$\Delta GDP_t = \theta_o + \sum_{i=1}^{\kappa} \theta_\iota \Delta GDP_{t-1} + \sum_{i=0}^{\kappa} \beta_i \Delta TFP_{t-i} + \sum_{i=0}^{\kappa} \gamma_i \Delta GRCF_{t-i} + \sum_{i=0}^{\kappa} \delta_i \Delta SCE_{t-i} + \sum_{i=0}^{\kappa} \vartheta_i \Delta LF_{t-i} + \sum_{i=0}^{\kappa} \sigma_i \Delta TO_{t-i} + \varphi \hat{\varepsilon}_{t-1} + \mu_t \quad (15)$$

Where,

Δ is "difference, φ the coefficient of error correction term, $\hat{\varepsilon}_{t-1}$ the error correction term μ_t the residual and k is optimum number of lags of the variable".

Wald Test

Agresti (1990) and Polit (1996) suggested a framework called Wald test. If the results from the Wald test are significant for a specific independent variable or set of these variables, formerly it would be decided that all the parameters related with these variables are non-zero, on basis of this result, variables would be involved in the empirical model. In case of insignificant Wald test, explanatory variables canbe omitted from model. For significance of parameters, Altman (1991) used a t-test, when seeing a one independent variable. The Wald-Statistic will be square of the t-statistic. So, that it will gives accurate statistics for unique parameter.

$$W = n(b)^{/} \left(\frac{\partial\delta}{\partial\beta} V \frac{\partial\delta}{\beta^{/}}\right)^{-1} \delta(b) \quad (16)$$

Where, "n" is number of observations, "b" is unrestricted parameter estimates and "V" is estimate of variance of b.

Granger Causality Test

Granger-Causality Test is used to study the direction of causation (Gujrati and Porter, 2009). This test contains following equations;

$$X_t = \text{"} \sum_{i=1}^{n} \alpha_i Y_{t-i} + \sum_{j=1}^{n} \beta_j X_{t-j} + \mu_{1t} \quad (17)$$
$$Y_t = \sum_{i=1}^{n} \gamma_i Y_{t-i} + \sum_{j=1}^{n} \delta_j X_{t-j} + \mu_{2t} \quad (18)$$

Where X_t and Y_t are variables which must be stationary, $\mu_{1t}$and μ_{2t} are disturbances and it is assumed that they are not correlated".

Results and Discussion

This section of the study delivers empirical results of the model. The initial step in the co-integration is testing stationary of time series data. Augmented Dickey Fuller (ADF) test has been used for testing stationary of variables. The null hypothesis is that there is unit root. The results of ADF are presented below.

Table 2 presents the results of ADF for all the series and revealed that the entire variable are non-stationary at level and after taking the first difference the series become stationary at first difference, therefore, integrated of I (1) a necessary precondition for applying Johanson and Jusilius (1988, 1995) technique. Now we may move forward towards the second step of co-integration.

Table 2: Augmented Dickey Fuller test

Variables	Level		1st difference	
	WOT	**WT**	**WOT**	**WT**
GDP	-1.196	-0.500	-4.664	-4.915**
TFP	-0.207	-2.211	-5.639	-5.590**
LF	-1.616	-1.638	-4.995	-5.196**
TO	-3.583	-3.360	-7.630	-7.904**
SE	0.203	-1.991	-5.351	-5.373**
GFCF	-1.422	-0.741	-4.985	-5.171**

Note: 5 % critical values WT, with trend WOT without trend.

Lag Length Selection Criteria

Lag length selection is important diagnostic while estimating relationships using Johansen Test of Co-integration regression. According to our results all criteria except SC recommends the lag length 4. So, to continue the next stage, lag length of 4 is selected. Lag length selection criteria is shown in table 3 below.

Table3: Lag-Length Decision Criteria

Lag	L.R	F.P.F	A.I.C	S.C	H.Q
0	N.A	1.46E-08	-1.0162	-0.7629*	-0.924
1	491.087	3.11E-14	-14.097	-12.324	-13.456
2	51.353	3.18E-14	-14.199	-10.906	-13.008
3	46.596	2.97E-14	-14.618	-9.8052	-12.878
4	53.533*	1.13E-14*	-14.387*	-10.054	-14.097*

Note: * shows the lag length selected by each criteria.

Johansen Test of Co-Integration

With the conformation of stationarity properties of the data set and lag length selection now we are able to apply co-integration test. Johansson's system for co-integration uses the two tests for choosing the appropriate number of co-integrating vectors or long run association among variables. Trace-test and Maximum-Eigen Value Test will be utilized for choosing the vicinity of long run association among the variables. Results of Trace test are presented in table 4 which confirms the existence of 5 co-integrating vectors at 5% significance level and results of Maximum Eigen value are in table 5.

Table 4: The Results of Trace-Test

No of CE(s)	Eigenvalue	Trace statistic	Critical value	Prob.**
None*	0.94	107.14	36.64	0.00
At most 1*	0.86	74.68	30.44	0.00
At most 2*	0.63	38.58	24.16	0.00
At most 3*	0.46	24.03	17.98	0.00
At most 4*	0.32	14.77	11.23	0.02
At most 5	0.09	3.49	4.13	0.09

Note: *Denote the rejection of null hypotheses at 5% level.

With the above results shown in the table 4 showed the significant values and at least 5 co-integration equations indicating that there is long run relationship in TFP and economic growth of Pakistan along with its control variables.

In Johansson and Juselius co-integration procedure there must be at least one co-integrated vector in model indicating the application of co-integration. As the trace test tends to have more distorted sizes whereas there power is in prior to that of the maximum eigenvalue test. The results of maximum Eigen value are presented as follows.

Table 5: Results of Maximum-Eigen Value test

No. of CE(s)	Eigen-value	Max-Eigen Statistic	Critical Value	Prob-value
At most 1*	0.86	155.54	60.07	0.00
At most 2*	0.63	80.87	640.18	0.00
At most 3*	0.46	42.29	24.28	0.00
At most 4*	0.32	18.26	12.33	0.00
At most 5	0.09	3.486	4.13	0.08
Note: *Donate rejection of the null hypotheses				

The Error Correction Model

For the purpose of short run analysis Error Correction Mechanism (ECM) is being applied in the model. The results as given below in Table 6.

Table 6: Results of ECM

	Coefficient	Std. Error	t-Statistic	Prob.
	-2.28	0.49	-4.58	0.00
D(Trade OF_GDP)				
D(SSE)	1.74	1.04	1.68	0.12
D(TFP)	-117.52	36.38	-3.22	0.02
D(LF)	-71.19	28.82	-2.46	0.04
D (Trade of GDP)(-1)	20.92	15.84	1.32	0.22
D (Trade of GDP)(-2)	0.59	0.28	2.14	0.06
D (Trade of GDP)(-3)	0.44	0.22	1.92	0.08
D (Trade of GDP)(-4)	0.24	0.18	1.36	0.22
D(SSE)(-1)	0.12	0.14	0.82	0.44
D(SSE)(-2)	8.29	1.89	4.38	0.02
D(SSE)(-3)	10.06	3.42	2.94	0.02
D(SSE)(-4)	2.52	2.34	1.06	0.32
D(TFP)(-1)	-3.14	1.74	-1.80	0.10
D(TFP)(-2)	-106.42	35.64	-2.98	0.01
D(TFP)(-3)	-186.92	65.76	-2.84	0.01
D(TFP)(-4)	-63.68	52.78	-1.20	0.25
D(LF)(-1)	79.84	40.32	1.98	0.07
D(LF)(-2)	-84.00	46.92	-1.79	0.10
D(LF)(-3)	-270.18	77.00	-3.50	0.00
D(LF)(-4)	-326.99	93.02	-3.52	0.00
D(GFCF)	-172.16	64.42	-2.68	0.02
D(CFGF)(-1)	-14.12	12.50	-1.12	0.28
D(CFGF)(-2)	-28.49	11.54	-2.46	0.04
D(CFGF)(-3)	-9.36	10.22	-0.92	0.38
D(CFGF)(-4)	11.34	7.48	1.52	0.16
D(GDP)(-1)	-132.66	41.38	-3.20	0.02
D(GDP)(-2)	-103.38	43.98	-2.36	0.04
D(GDP)(-3)	-42.24	31.34	-1.34	0.22
D(GDP)(-4)	-32.64	26.54	-1.24	0.24
DGDP)	41.52	10.96	3.78	0.00

Note: Granger Causality test results from data sample 1980-2019

Econometric validity for a short run equilibrium is indicated by ECM equation C1 to be negative and significant. The minus sign indicating that there is long run causality running from independent variable to dependent variable. ECM tells us the speed with which our model runs to equilibrium following an exogenous stock. In above table 6, significance value of error term is obtained 0.001 that reflect the speed of adjustment is very slow that shows, for human capital it adjusts very slowly in case of Pakistan.

Coefficient Diagnostics: Wald-Test

Wald-test has been used to find out significance of explanatory variables.

Table 7: Normalized Restriction (=0)

	C. Value	Std. Err.	Prob.
C(1)	-2.28	0.49	0.00
C(2)	1.74	1.04	0.00
C(3)	-1.18	36.38	0.02
C(4)	-71.19	28.8	0.01
C(5)	20.92	15.84	0.00
C(6)	0.59	0.28	0.00

Note: Wald test results

With normalized restriction (=0) it is found that all variables are significant and show rejection of null hypothesis so these variables cannot be dropped from the model.

Granger Causality Test

Granger-Causality test has been applied among variables and results have been incorporated in table 8 below.

Table 8: Granger Causality Test Results

Pairwise Hypothesis	Obs.	F-Statistics	P-value	Decision	Type of causality
SCE ➔ TO	41	0.92	0.29	DNR H0	No causality
TO ➔ SCE	41	1.28	0.48	DNR H0	No causality
TFP ➔ TO	41	0.86	0.22	DNR H0	No causality
TO ➔ TFP	41	1.58	0.52	DNR H0	No causality
LF ➔ TO	41	0.76	0.76	DNR H0	No causality
TO ➔ LF	41	0.38	0.94	DNR H0	No causality
GFC ➔ TO	41	0.12	0.84	DNR H0	No causality
TO ➔ GFCF	41	0.28	0.14	DNR H0	No causality
GDP ➔ TO	41	2.02	0.48	DNR H0	No causality
TO ➔ GDP	41	0.84	0.84	DNR H0	No causality
TFP ➔ SSE	41	0.28	0.88	DNR H0	No causality
SSE ➔ TFP	41	0.24	0.02	Reject H0	Uni-directional causality
LF ➔ SSE	41	3.62	0.02	Reject H0	Bi-directional causality
SSE ➔ LF	41	4.38	0.06	Reject H0	Bi-directional causality
GFCF ➔ SSE	41	2.86	0.02	Reject H0	Bi-directional causality
SSE ➔ GFCF	41	4.40	0.06	Reject H0	Bi-directional causality

GDP ➔ SSE	41	4.19	0.01	Reject H0	Bi-directional causality
SSE ➔ GDP	41	3.26	0.04	Reject H0	Bi-directional causality
LF ➔ TFP	41	3.69	0.02	Reject H0	Bi-directional causality
TFP ➔ LF	41	3.28	0.02	Reject H0	Bi-directional causality
GDP ➔ TFP	41	3.84	0.02	Reject H0	Bi-directional causality
TFP ➔ GDP	41	3.56	0.02	Reject H0	Bi-directional causality
GFCF ➔ LF	41	6.09	0.00	Reject H0	Bi-directional causality
LF ➔ FCF	41	0.24	0.08	Reject H0	Uni-directional causality
GDP ➔ LF	41	0.69	0.56	DNR H0	No causality
LF ➔ GDP	41	0.12	0.94	DNR H0	No causality
GDP ➔ GFCF	41	0.79	0.50	DNR H0	No causality
FGCF ➔ GDP	41	6.08	0.00	Reject H0	Uni-directional causality

Note: α = 0.05, Decision rule: reject H0 if P-value < 0.05. Key: DNR = Do not reject; ➔ = does not Granger cause.

Here above fifteen VAR models have been formulized to test Pairwise Granger causality between economic indicators on the basis of theory discussed in previous section above results are found. It can be see that following bi-directional and uni-directional causality occurs among some particular economic indicators: Secondary school enrollment Granger causes total factor productivity, labour force Granger causes GFCF and GFCF causes GDP. The bi-directional causality results are: labor force Granger causes Secondary school enrollment, secondary school enrollment Granger cause labor force. Gross fixed capital formation Granger Causes Secondary school enrollment, Secondary school enrollment Granger cause Gross fixed capital formation. Labor force Granger causes TFP, as TFP Granger cause labour force. GDP Granger causes TFP and TFP Granger causes GDP. The results here approve the former co-integration analysis that shows we have at least five co-integrated equations in the model.

Conclusion

The study was intended to investigate TFP and growth nexus for Pakistan using latest time series data. It reported that influence of TFP was much more significant in attaining the high growth fluctuates from 5.6 percent in the period 1973-77 to 6.6 percent in the period 2003-2006. In other words the economic growth of Pakistan through 2003-2006, was essentially determined by the enrichment of TFP and less growth through the 1970s and 1990s was mainly due to a huge decline in TFP. Pakistan have reached at the extraordinary economic growth level during the 1980s also, that was to an amount similarly contributed by both TFP and inputs availability.

The expansionary and contractionary monetary and fiscal policies are responsible for the less growth of TFP in period 1992-2002 and higher TFP in the 2002-06 eras respectively (Khalil 2007). Human capital enhancement accounted positively to the economy of Pakistan. This shows the significance of floating human capital endowment and economic extension services to the labour force to realize growths in TFP in economy of Pakistan. After 2000 the growth in TPF is mainly attributed by the development in the human capital. There are some other determinants of TFP like exports of industrial goods and fiscal policy incentives canbe researched for their roles in the course of sustained and inclusive growth processes.

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