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Measuring Total Factor Productivity and Finding the Determinants of Total Factor Productivity at Sectoral Level: A Case Study of Pakistan

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Abstract
The current study has attempted to measure the total factor productivity at sectoral level. For this, the stock of capital series which was constructed by Kemal and Ahmad (1992) has been extended till 2013. The Solow residual has been calculated through growth accounting framework. The sectoral TFP is tested against the macroeconomic variables, such as human capital, openness of the economy, transfer of technology, financial development and development expenditure by the government. Using the ARDL methodology, it has been found that agriculture sector has the potential to grow provided there is investment in human capital and the agriculturists do acquire appropriate technology. The manufacturing sector TFP growth, on the other hand, not only requires further investment in human capital, it also requires diversification of the economy and its opening up to international trade transactions, financial development of the economy, and the use of technological advances in the field. The study also supports the Keynesian argument that government development expenditure is growth promoting.
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1. Introduction

Accumulation of resources and technological development are the key sources of economic growth. Out of these two sources technological changes has been the main source of economic growth in developed countries. While most of the developing countries focused on just the accumulation of the resources and very little focus is being paid to increase the overall productivity of the factors of production. The productivity of the factors of production can be increased through the technological progress. Technological changes may further be divided into embodied and disembodied technological changes. Embodied technological changes involved in acquisition of new machines and equipment which include advanced production technique. Most of the new technological knowhow is embodied in capital equipment whose accumulation is measured through the level of gross investment, so it is argued that the long-term rate of growth will be slow down by anything which causes the slowing of the rate at which the new technologies embodied through investment. While disembodied technological changes take place through advancement in managerial skills, information, human quality and learning capacity. It is needed to underline that not all new technology will boost the total factor productivity, but only that technology can do, which could bring changes in the factor endowment. And this will be possible if a country has a sizable and efficient capital good producing sector or a country is highly involved in research and development program.

Technological changes in agriculture are both essential and sufficient condition for its development, as it provides the opportunity to agriculture sector to avoid from the Ricardo's law of diminishing return to sector to which the sector is more prone. And it is sufficient condition because it raises the efficiency level of the labor which leads to higher productivity and reduces cost per unit in real term. The significance of agriculture sector to the economy is seen in three directions; first, it allows food to domestic consumers and fibers for domestic industry; second, it is a source of foreign exchange earnings; and third, it provides a market for industrial goods.

Productivity growth is crucial in the sense that, they not only increase output, but also improve the competitiveness of an industry both in the domestic and international markets. It becomes pertinent to analyze the productivity recital of the industrial sector which is facing stiff competition from outside world in the present era of globalization and liberalization where the role of government is restricted.

Total factor productivity is the most comprehensive measure of the aggregate and sectoral productivity. However, the given inadequacy of good data, this arena of research has remained quite limited in Pakistan. There have been only few studies to estimate total factor productivity, even fewer attempts had been made to discover the significance of the macroeconomic variable on total factor productivity. The studies of Wizarat (1981) and Kemal and Islam (1992) are the groundbreaker studies of estimating total factor productivity, but most of these studies are superannuated and generically based on incomplete data set whereas their utility is quite restrained. A confined attempt is also made on highlighting the macroeconomic determinant of TFP, like studies of Pasha et al (2002) and Khan (2006). But all these studies are on aggregate level and mostly concentrated on input factor as a source of long-term growth.

There are few studies regarding to sectoral TFP measurement of Pakistan economy, like the studies of Cheema (1978) and Kemal (1979). All these studies are outdated and based on CMI (census of manufacturing industries) data, and suffer from the estimation of capital stock. But there is no any attempt to highlight the factor responsible for changes TFP in both sectors. In this respect the study takes the series of capital stock calculated by Kemal and Ahmad (1992) extend till 2013. The total factor productivity is calculated and finds the determinant of total factor productivity at sectoral level. Since there is no official bureau and an effective mechanism to maintain the TFP index and efficiency of the resources on regular basis for agriculture and manufacturing sectors, the current study provide a fresh perspective on the growth of TFP in both sectors and fill the important gap that is arias from the earlier studies.

There is substantial support to the argument that accumulation of knowledge capital, acquiring modern technology and openness of the economy to international trade has significant impact on productivity improvement. In the recent years Benhabib and Spiegal (1994), Black and Lynch (1996) Hall and Jons (1999), Hamid and Pichler (2009) and Pasha et al (2002) point out that human capital accumulation promote growth via improvement in productivity. Higher human capital stock will have higher catch-up rate of new technology. While Edwards (1997), Chand and Sen (2002), Ferreira and Rossi (2003), Dowrick and Golley (2004), Siddiqui and Iqbal (2005) and Chaudry et al (2010) investigate a robust relationship between openness of economy and total factor productivity growth that a more open economy grows at a faster rate than a less open economy. Keller (1997), Kasahara and Rodrigue (2004), Loof and Anderson (2008), Augier et al (2010),Borensztein et al (1997) and Djankov and Hoekman (2002) find out that switching from non-importer being an importer of intermediate goods boost the productivity of domestic factor of production because imports of intermediate goods allow domestically foreign technology diffusion.

The main objective of the study is to understand the phenomenon of the technological changes (TFP) in Pakistan at sectoral level. To look over the impact of domestic factors such as human capital, financial development and development expenditure by government on total factor productivity and to examine the relationship between transfer of technology, openness of the economy and total factor productivity.

The paper is organized as follows; Section II begins with details related to data and research methodology, Section III presents the results and discussion, and concluding statements are provided in the last Section IV.

2. Data and Research Methodology

The study conduct the analysis into two stages, at first stage the different method both parametric and growth accounting/index methodology is been used to calculate the total factor productivity and in the second stage the impact of macroeconomic variables on total factor productivity has been explored.

The growth accounting frame work

The growth accounting framework was first undertake by Stigler (1947), and finally brought to realization by Kendrick (1961). This approach gives more scope for disintegration of the contribution of factors inputs and the technological changes to economic growth. Let assume a general neo-classical production function.

$Y_{(t)} = A_{(t)} \cdot F[\ K_{(t)}, L_{(t)}\ ]$ (1)

Now by logarithm on both sides we get the following equation.

$\ln Y(t) = \ln A(t) + \ln F[\ K(t),\ L(t)]$ (2)

Now taking differentiation with respect to time, and using the identity of d ln x (t)/dt = ẋ(t)/x(t). We get.

$$\dot{Y}(t)/Y(t) = \mathring{A}(t)/A(t) + Fk/F[K(t),L(t)] \cdot \acute{K}(t) + Fl/F[K(t),L(t)] \cdot \dot{L}(t) \quad (3)$$

Using the identity of $Y_{(t)} / A_{(t)} = F[\ K_{(t)}, L_{(t)}\ ]$

$$\dot{Y}(t)/Y(t) = \mathring{A}(t)/A(t) + A(t).Fk/Y(t) \cdot \acute{K}(t) + A(t).Fl/Y(t) \cdot \dot{L}(t) \quad (3)$$

Now by rearranging we get

$$\dot{Y}(t)/_{Y(t)} = \mathring{A}(t)/_{A(t)} + A(t).Fk.K(t)/_{Y(t)} \cdot \frac{\acute{K}(t)}{K(t)} + A(t).Fl.L(t)/_{Y(t)} \cdot \frac{\dot{L}(t)}{L(t)} \quad (4)$$

If we assume that the capital and labor market are competitive then the share of the marginal product of the factor will be equal to their respective price. Then we have
$\frac{\Delta Y}{\Delta K} = A\frac{\partial Y}{\partial K} = AF_k, \frac{\Delta Y}{\Delta L} = A\frac{\partial Y}{\partial L} = AF_L$. The marginal product of capital and labor,
So the equation 10 can be transfer in to the following equation.

$$\dot{Y}(t)/_{Y(t)} = \mathring{A}(t)/_{A(t)} + r.K(t)/_{Y(t)} \cdot \frac{\acute{K}(t)}{K(t)} + w.\ L(t)/_{Y(t)} \cdot \frac{\dot{L}(t)}{L(t)} \quad (5)$$

Where (r) is the price of capital and (w) is the price of labor, the $r.K(t)/_{Y(t)}$ and $w.L(t)/_{Y(t)}$ are the respective share of capital and labor in the total income, and the above equation 5 can be written as in term of technological growth.

$$\mathring{A}(t)/_{A(t)} = \dot{Y}(t)/_{Y(t)} - r.K(t)/_{Y(t)} \cdot \frac{\acute{K}(t)}{K(t)} - w.L(t)/_{Y(t)} \cdot \frac{\dot{L}(t)}{L(t)} \quad (6)$$

From above equation 6 one can calculate the total factor productivity.

In this section an attempt is made to model the residual obtained from the above procedure to test the hypothesis that total factor productivity is depend upon , human capital, openness of the economy, transfer of technology and government development expenditure. For this proposes the model of Savvides and Zachariadis (2004) Hulten and Isaksson (2007) is used.
The general form of the model is,
$TFP = f\,(HC\,, OP\,, TT, D.E,\ F.D)$ (7)
Where TFP is stand for total factor productivity, HC is human capital, OP is openness of the economy, TT is transfer of technology, D.E is development expenditure and F.D is financial development
Here we know thattransfer of technology is a function of foreign direct investment and imports of intermediate goods and machinery so,
$TT = f\,(FDI\,,\ IM_g)$ (8)
Where FDI is stand for foreign direct investment and IM_g represent the imports of machinery and inter mediate goods. Now substituting equation no, 8 in to equation no, 7 we get the final equation of the study.
$TFP = f\big(HC\,, OP\,, FDI\,,\ IM_g\,, DE,\ M2\,\big)$ (9)
Empirically the given model can be written as
$TFP_t = a_0 + a_1HC_t + a_2OP_t + a_3FDI_t + a_4IMg_t + a_5DE_t + a_6\,M2 + u_t$ (10)

Data and Variables Description
Major sources of the data are 50 year of Pakistan statistics, economic surveys of Pakistan, international finance statistics, census of manufacturing industries, and wage structure of Pakistan by Muhammad Irfan for the period of 1973-2013. The data of Gross domestic product, labor force, gross fixed capital formation, wages, interest rate, data on sectoral GDP is taken from handbook of statistics on Pakistan economy 2010. While the data sectoral labor force is taken from economics server of Pakistan. Data on GFCF is taken from handbook of statistics on Pakistan economy 2010 to calculate the capital stock series for both sectors; the methodology of calculating capital stock is giving in appendix B.

Hall and Jones (1999) used educational attainment of worker is a proxy for human capital, while Benhabib and Spiegel (1994) use the average number of schooling of the labor force is a proxy for human capital and enrolment in secondary, higher and professional vocational colleges and universities as a ratio of total labor force is proxy for human capital by Hamid and Picher (2009). Here we used government expenditure on education and vocational training is proxy for human capital. The data on educational expenditure is taken from Handbook of Statistics on Pakistan Economy 2010 from 1973-2013. The term "Op'' represent the openness of the economy, both in the theoretical and empirical literature openness of the economy is defined differently, Ferreira and Rossi (2003) use the effective rate of protection of the economy a proxy for openness. While Ali Malik et al (2010) use the exports plus imports as a percentage of GDP, Jajri (2007) use trade to GDP ratio, and Siddiqui and Iqbal (2005) is used trade volume a proxy for openness, so we use the trade to GDP ratio is a proxy for openness. Data on openness is not available; here we have calculated it from the data on exports, imports and

GDP. The data on these variables was taken from handbook of statistics on Pakistan 2010 ranging from 1973 t0 2013.

The transfer of technology is described by the term "TT" in equation 18. Technology may be transfers through different ways, it will be transfer through either to FDI or through imports of machinery or imports of intermediate goods etc. it means that transfer of technology is a function of FDI and imports of machinery and intermediate goods. So later we replace the "TT" by FDI and imports of intermediate good and machinery. And data on both variables is available in the hand book of Pakistan statistic so there is no need of proxy been used.

The term D.E represents the development expenditure by government; in literature it shown that development expenditure can raises the total factor productivity which tern to reduce the rural poverty, Aschaver (1988) and Fan et al (2002) point out that government expenditure on agriculture R & D will raises the factor productivity in agriculture sector which will lead to higher wages and investment in non-agriculture employment. Data on development expenditure is also taken from handbook of statistics on Pakistan economy 2013.

Econometric specification of the model

Econometricians suggest several methodologies to determine whether long-run relationship exists between the variables or not. While this study used the technique of Pesaran and Shin (1999) namely known as the ARDL (Autoregressive Distributed Lag Model). This technique has several advantages over the other method of co-integration. One of its prime advantages is that, it can be applied irrespectively whether the variable is order of integrated I (0) or I (1). Moreover ARDL can also be applied on small sample size.

ARDL Model

$$\Delta TFP_i = \beta_0 + \sum_{i=1}^{t} \delta_i \Delta TFP_{t-i} + \sum_{i=1}^{t} \emptyset_i \Delta Hc_{t-i} + \sum_{i=1}^{t} \omega_i \Delta Op_{t-i} + \sum_{i=1}^{t} \varphi_i \Delta FDI_{t-1} + \sum_{i=1}^{t} \rho_i \Delta IMg_{t-1} + \sum_{i=1}^{t} \vartheta_i \Delta DE_{t-1} + \sum_{i=1}^{t} \bar{\upsilon}_i \Delta M2_{t-i} +$$

$$\lambda_1 TFP_{t-1} + \lambda_2 Hc_{t-1} + \lambda_3 Op_{t-1} + \lambda_4 FDI_{t-1} + \lambda_5 IMg_{t-1} + \lambda_6 DE_{t-1} + \lambda_7 M2_{t-1} + \mu_t \quad (11)$$

Where β_0 is the drift component and the termsδ_i,$\emptyset_i$, ω_i, φ_i, ρ_i, $\bar{\upsilon}_i$ and ϑ_i are the parameters used for short-run analysis while λ_1, λ_2, λ_3, λ_4, λ_5,λ_6 and λ_7 are used for estimating long-run parameters. To test the long-run relationship or co-integration between the TFP and the given variables Wald restriction test is used and for this F-test value has been used. The value of the F-test is taken by applying the coefficient diagnostic Wald restriction test on long run variable parameters. Hypothesis for the co-integration test is

$H_0 = \lambda_2 = \lambda_3 = \lambda_4 = \lambda_5 = \lambda_6 = \lambda_7 = 0$ (Means no co-integration)
$H_0 = \lambda_2 \neq \lambda_3 \neq \lambda_4 \neq \lambda_5 \neq \lambda_6 \neq \lambda_7 \neq 0$ (Means there is co-integration)

F-test is based on the number of regressor in the model. If the F-stat value is greater than the value of the upper bound then we will reject the null hypothesis and conclude that, there is co-integration means long-run relationship exists between the dependent and independent variables. If the value of the F-stat is lower than the value of the lower bound then the null hypothesis is not rejected, and show that there is no co-integration means, no long-run relation is exist between the regressor and represents and finally if the F-stat is between the lower bound and upper bound then the it show that the result is inconclusive.

The critical values against which F-stat are compared with the table tabulated by Pesaran and Shin (1999) and Pesaran et al, (2000). The orders of the lag length in the ARDL model are selected either through the Akaike's information criteria (AIC) or through the Schwarz Bayesian criterion (SBC). The second option is to start with maximum lag length usual the general model, and drop the insignificant variable. Once the co-integration is proved then, next we will have to find the values of the long-run parameters by normalizing the long run equation and estimating the error correction model for short run analysis.

Under the assumption of steady-stat condition long run equation is; $\Delta TFp_i = 0$

Means that $\Delta TFP = TFP_t - TFP_{t-1} = 0 \Rightarrow TFP_t = TFP_{t-1}$

$$\lambda_1 TFP_{t-1} = \beta_0 + \lambda_2 Hc_{t-1} + \lambda_3 Op_{t-1} + \lambda_4 FDI_{t-1} + \lambda_5 IMg_{t-1} + \lambda_6 DE_{t-1} + \lambda_7 M2_{t-1} \quad (12)$$

Now replacing $TFP_t = TFP_{t-1}$ and dividing both sides by λ_1 we will get the long-run parameters.

$$\lambda_1/_{\lambda_1} TFP_t = \beta_0 + \lambda_2/_{\lambda_1} Hc_{t-1} + \lambda_3/_{\lambda_1} Op_{t-1} + \lambda_4/_{\lambda_1} FDI_{t-1} + \lambda_5/_{\lambda_1} + \lambda_6/_{\lambda_1} DE_{t-1} + \lambda_7/_{\lambda_1} M2_{t-1}$$

Now by re-parameter rising,

$$TFP_t = \psi_0 + \psi_1 Hc_{t-1} + \psi_2 Op_{t-1} + \psi_3 FDI_{t-1} + \psi_4 IMg_{t-1} + \psi_5 DE_{t-1} + \psi_6 M2_{t-1} \quad (13)$$

Now the ψ_1 , $\psi_{2,}$ $\psi_{3,}\psi_{4,}\psi_5 and \psi_6$ are the long run parameters there values and signs will determined the long run relationship between the dependent variable and independent variables in the model. For short run analysis the error correction model has been used.

Error Correction Model

When a long-run relationship exists between the variables then there is an error correction representative model, so the following error correction model is run in the third step.

$$\Delta TFP_i = \beta_0 + \sum_{i=1}^{p} \delta_i \Delta TFP_{t-i} + \sum_{i=1}^{q} \emptyset_i \Delta Hc_{t-i} + \sum_{i=1}^{r} \omega_i \Delta Op_{t-i} + \sum_{i=1}^{s} \varphi_i \Delta FDI_{t-1} + \sum_{i=1}^{t} \rho_i \Delta IMg_{t-1} + \sum_{i=1}^{u} \vartheta_i \Delta DE_{t-1} + \sum_{i=1}^{v} \bar{\upsilon}_i \Delta M2_{t-i} + \gamma_0 ECM1_{t-1} + V_t \quad (14)$$

The error correction model indicates the speed of the adjustment of the short run shocks back to a long-run equilibrium. The coefficient of the ECM1 determined the speed of adjustment toward equilibrium in case of any disturbance.

3. Result and Discussion

Unit roots Test

To avoid the problem of spurious relationship we first test the stationarity of the variables, for this purpose the ADF (Augmented Dickey Fuller) test is applied to check the stationarity that whether the variable is stationary or not. The Null hypothesis that the variable is a unit root means non-stationary was tested against the alternative hypothesis that the variable is stationarity by the ADF regressions. The following table 1 shows the result of the unit root tests.

Table 1: Unit root test	
Agriculture TFP	*I (0)*
(D.E)	*I(1)*
(FDI)	*I(1)*
Openness	*I(0)*
(HC)	*I(1)*
IM(machine& goods)	*I(0)*
M_2 /GDP ratio	*I(1)*
Manufacturing TFP	*I(1)*

The above table indicates that the variable Agriculture sector TFP (total factor productivity) is stationary in level form. The term D.E (development expenditure by government) indicates that the variable is trend stationary at first difference. Foreign Direct Investment (FDI) is stationary after taking the difference. The variable Openness is trend stationary at level form. The variable (Hc) is difference stationary and import of machinery and intermediate goods is trend stationary in level form. The variables M2/GDP ratio a proxy for financial development is become stationary after taking difference. Manufacturing TFP is stationary at first difference.

After testing the unit root of the variables through the ADF technique, it was found that the all variables have not the same order of stationarity; means some variable have order of integrated I (0) while some have order of I (1). As the unit root indicates that the variable Agriculture TFP, Openness and imports of machinery and intermediate goods and equipment are I (0), while the variable FDI, Development expenditure, human capital, M2/GDP ratio and manufacturing TFP are I (0). Thus it allowed us to use the technique of ARDL for testing the long-run relationship or co-integration among the variables. The ARDL model specification don through the AIC criteria which allow us to take the first lag length of the variable.

The ARDL technique is applied on equation no ‘‘11’’ in which the coefficient with the difference are used for the short run interpretation and the coefficient with first lag of the variables are used for the long run. In the below table the coefficient are given with their standard and t-value.

Estimated ARDL Model for Agriculture Sector

ΔTFP = 5.947 − 0.363Δ (TFP_1) + 0.193Δ (Hc) - 0.188Δ (Op) + 0.0469Δ (FDI) +0.145Δ (IM) −0.168Δ (IM_1) −0.160Δ (D.E) − 0.390Δ (M2) + 0.283Δ (M2_2) + 0.556Δ (M2_1) − 0.656TFP_1 +0.228Hc_1 +0.402Op_1 + 0.087FDI_1 + 0.299IM_1 + 0.374D.E_1 −0.894M2_1+μ_t

The robustness of the model has been checked by several diagnostic tests such as Breusch- Godfrey serial correlation LM test, ARCH test, Jacque-Bera normality test and Ramsey RESET specification test. All the tests confirmed, that the model has the ambition econometric properties, it has a well correct functional form and the

model's residuals are serially uncorrelated, normally distributed and homoskedastic. As a result, the outcomes described are serially uncorrelated, normally distributed and homoskedastic. Hence, the results reported are valid for consistent interpretation. Before going to interpretation of the coefficients first we apply the Wald restriction test on the long run coefficients to check the co-integration that, whether there is a long run relationship among the dependent and independent variables exist or not. The Wald restriction test applied under the null hypothesis that there is no co-integration between the variables against the alternative hypothesis that there is co-integration or long run relation among variables. The F-calculated value obtained from Wald restriction test is greater than the upper bound value, taken from Pesran et al (2000) table, F-calculated 14.46553> the upper bound value (4.43). Thus we reject the null hypothesis of no co-integration, and conclude that there is a long run relationship between the variables.The ARDL equation and diagnostic tests are given in appendix A (See table 1 to 4).
To explain the long run parameters we first normalize the equation by assuming that at steady state condition the ΔTFP = 0 means that $\Delta TFP = TFP_t - TFP_{t-1} = 0 \Rightarrow TFP_t = TFP_{t-1}$ so from this restriction the all the differenced variables must be disappeared. And we will get the following equation of the long run parameters.

0 = 0.656TFP_1 +0.228Hc_1 +0.402Op_1 + 0.087FDI_1 + 0.299IM_1 + 0.374D.E_1 – 0.894M2_1

Now substituting the TFP = TFP_1 and same for the other variables, and by rearranging we get,

0.656TFP = +0.228Hc +0.402Op + 0.087FDI + 0.299IM + 0.374D.E –0.894M2

Now divide both sides through the coefficient of TFP then we get,

TFP = 0.348*Hc +0.612*Op +0.133*FDI +0.456*IM +0.569*D.E −1.3618*M2

The above equation shows the long run parameters for the model, the signs of the all estimated coefficient of the macroeconomic variables are according to the priori expectation except the sign of M2 denoting the proxy of financial development. To interpret the coefficient of the long run parameters we start from human capital, the sign of the human capital variable is positive, showing that there is a positive relationship between the human capital and agriculture total factor productivity. The government expenditure on education and training and vocational training has been utilized is a proxy for human capital. The coefficient of Human capital is 0.348 indicating, that a 1% increased on education and training expenditure by government will raise the agriculture total factors productivity by 0.348 %. The result confirms the finding of Khan (2006). Government expenditure on education and vocational training will promotes more skilled and specialized labor input. Since further skilled workers are superior to adjust in a dynamic, knowledge-based economy, and this result in improved productivity performance. The coefficient of the openness comes with positive sign, showing a positive relationship between economic openness and agriculture productivity.

Openness of the economy not only eliminate the distortion in production market and as well as in the factors market but it also provide access to foreign intermediate goods which are involved in high R & D expenditure. So openness has a positive and favorable impact on technological changes. The estimated result shows that a 1% increase in trade to GDP ratio or opening the economy by 1% will raise the total factor productivity by 0.612 percent, and confirm the finding of Kemal and Naqve (1992), that opening the economy to international trade will promote growth in the economy.

In order to capture the impact of transfer of technology, we have introduced two variables for it, one is FDI and the other one is Imports of machinery and intermediate goods. It is generally believed and also the literature suggest the foreign direct investment is the key to transfer the technology from highly technological countries to developing countries, which raise not the existing capital stock but have also some positive externality. This externality occurs in the form of technology diffusion, new technique of production, skill improvement and managerial techniques. In order to capture the full advantage of FDI the country must have a sufficient stock of capital, the sector which has high level of human capital we get more benefit from FDI and vice versa.

The estimated result confirm a positive relationship between FDI and total factor productivity as found in the literature, like Borensztein et al, (1997) and Djankov and Hockman (2002), there finding suggest that foreign investment has a positive impact on domestic firm productivity. The empirics of the result show that a one percent increases in foreign direct investment will increase the agriculture total factor productivity by .133 percent.

As we know that technology may be transfer either through the import of intermediate goods or through the multinational corporation. Technology is embodied in capital and the import of intermediate goods and thus the direct import of intermediate good is one of the channels of technological diffusion across countries. The import of machinery and intermediate goods are positively related to enhancing productivity growth in the developing countries. Previous empirical work using cross countries data that import of intermediate goods which are embodied highly R &D expenditure from highly technological developed nations can significantly boost the country productivity Keller (1997), Kasahara and Rodrigue (2004) and Loof and Anderson (2008). The estimated result also confirms the earlier studies, showing a positive relationship between Imports of machinery and intermediate goods and total factor productivity of the agriculture sector. The result indicates that a one percent increase in imports of machinery and intermediate goods will increase the TFP by 0.456 percent.

It is generally believed that government expenditure enhance productivity, government interference in some time very important to produce public collective goods because the private sector is unable to produce such goods, Government expenditure on infrastructure such as highways, airports, water system, streets have been a direct effect on productivity. Government expenditure on agriculture research and development will raise the agriculture productivity, which turn to decrease the rural poverty as point out Aschaver (1988) and Fan et al. (2009). The estimated result confirm that there is a positive relationship between the government development expenditure and total factor productivity of agriculture sector, that a one percent increase in the government development expenditure will raises the agriculture productivity by 0.569 percent.

Technological innovations and improvements become faster as the financial sector helps bringing out the prospective rewards to engaging in innovations, relative to continue making existing products with existing techniques. Capital accumulation will be more rapid if the financial sector induces people to save more to bring the foreign technology which is highly efficient and productive. But unexpectedly the estimated result for financial development comes out negative showing that a one percent increase in M2 to GDP ratio will decrease the total factor productivity of agriculture sector by 1.362 percent.

Error Correction Model

Error correction model is to look over the short run impact of the observed variable on the total factor productivity; the error correction model indicates the speed of the adjustment of the short run shocks back to a long-run equilibrium. The coefficient of the ECM determined the speed of adjustment toward equilibrium in case of any disturbance. The below table shows the result of the error correction model

$$\Delta TFP = \underset{(0.000)}{6.604910} - \underset{(0.0042)}{0.399027\Delta TFP_{t-1}} + \underset{(0.0004)}{0.201563\Delta Hc} - \underset{(0.0018)}{0.220130\Delta Op} + \underset{(0.001)}{0.055288\Delta FDI} +$$
$$\underset{(0.0007)}{0.140338\Delta IM} - \underset{(0.000)}{0.173279\Delta IM_{t-1}} + \underset{(0.0003)}{0.161092\Delta D.E} - \underset{(0.0003)}{0.434827\Delta M2} + \underset{(0.000)}{0.628228\Delta M2_{t-1}} +$$
$$\underset{(0.0015)}{0.341384\Delta M2_{t-2}} - \underset{(0.098)}{0.497083ECM1}$$

The estimated error correction term is significant at 10 % level of significant, and observed that the ECM term is with negative sign showing the convergence power of the model. The estimated result shows that any disturbance or shock wills not permanently deviates the model from equilibrium path. It also justify that the functional form of the model is correct. The coefficient of the error correction term is − 0.497083 indicates high adjustment process. Nearly 50% of the disequilibria of the pervious period's shock adjust back to the current period long run equilibrium.

The result further suggest that in the short run all the variable are with their expected positive sign except the sign of openness and financial development, that comes with a negative signs. The short run and long run sign of the financial development is same confirming the relationship between financial development and agriculture productivity, but there lag terms comes with positive sign. There are no differences in the short run and long run impacts of all variables except the openness. The educational expenditure by government, foreign direct investment, imports of machinery and intermediate goods, development expenditure by public exert a positive and significant impact on agriculture productivity. For diagnostic test see the appendix table 5, 6 and 7. The CUSUM and CUSUMSQ line are within the boundaries, showing the regression equation is stable. The figure of the CUSUM and CUSUMSQ plots are given in appendix. See fig 1 and 2.

Estimated ARDL Model for Manufacturing Sector

The result of the ARDL model for manufacturing sector is given below; the coefficients are given with their standard error and t-values. All the diagnostic confirmed, that the model has the desire econometric properties, it has a well correct functional form and the model's residuals are serially uncorrelated, normally distributed and homoskedastic. As a result, the outcomes described are serially uncorrelated, normally distributed and homoskedastic. Hence, the results reported are valid for reliable interpretation.

The F-calculated value obtained from Wald restriction test is greater than the upper bound value, taken from Pesran et al (2000) table, F-calculated 6.694896> the upper bound value (4.43). Thus we reject the null hypothesis of no co-integration, and conclude that there is a long run relationship between the variables. The ARDL equation and diagnostic tests are given in appendix A (See table 8, 9 and 10). The ARDL equation for manufacturing sector is

$$\Delta TFP = -2.565173 + 0.106458\Delta(TFP\_1) - 0.1067\Delta(Hc) - 0.157749\Delta(Op) - 0.009350\Delta(FDI) + 0.079360\Delta(IM) + 0.051614\Delta(D.E) - 0.067909\Delta(D.E\_1) - 0.343310\Delta(M2) - 0.31618TFP\_1 + 0.173018Hc\_1 + 0.143223Op\_1 + 0.066785FDI\_1 + 0.098054IM\_1 + 0.166745D.E\_1 + 0.315615M2\_1 + \mu_t$$

From the above model criteria and diagnostic study of the model suggest that, that the model is will specified and can be used for further interpretation, so know we use it for obtaining long run parameter and explanation.

To explain the long run parameters we first normalize the equation by assuming that at steady state condition the ΔTFP = 0 means that $\Delta TFP = TFP_t - TFP_{t-1} = 0 \Rightarrow TFP_t = TFP_{t-1}$ so from this restriction the all the differenced variables must be disappeared. And we will get the following equation of the long run parameters.
0 = 0.31618TFP_1 +0.173018Hc_1 +0.143223Op_1 + 0.066785FDI_1 + 0.098054IM_1 + 0.166745D.E_1 + 0.315615M2_1
Now substituting the TFP = TFP_1 and same for the other variables, and by rearranging we get,
0.31618TFP = +0.173018Hc +0.143223Op + 0.066785FDI + 0.098054IM + 0.166745D.E +0.315615M2
Now by dividing both sides by the coefficient by TFP we will get the long run parameter.
TFP = +0.547208Hc +0.452975Op + 0.211223FDI +0.310118IM + 0.527369D.E +0.998204M2
The above equation shows the long run parameter for the model, the signs of the estimated coefficient of these macroeconomic variables are according to the prior expectation, To interpret the coefficient of the long run parameters we start from human capital, the sign of the human capital variable is positive, showing that there is a positive relationship between the human capital and manufacturing total factor productivity. The government expenditure on education and training and vocational training has been utilized is a proxy for human capital. The estimated result shows that a one percent increase in expenditure on education means that if government raises the educational expenditure as a percentage of GDP by 1% it will enhance the manufacturing total factor productivity by 0.547 percent. The estimated result confirms the finding of the Black and Lynch (1996), that expenditure on employee training will significantly raise the manufacturing productivity.

It is clear from the both theoretical and as well as empirical literature, that moving from protectionist policy toward more open liberal trade policy will enhance domestic growth. Kemal and Naqvi and Kemal (199) point out that lost from protectionist policy of Pakistan account 6% of the GNP, so opening the economy to international trade not only eliminate this distortion but it will also provide access to international markets of intermediate goods and advance technology. The estimated result confirms that openness is positively related to manufacturing productivity, opening the economy by 1% will increase the manufacturing total factor productivity by 0.452 percent.

It is generally believed that, foreign direct investment is the key to transfer the technology from highly technological countries to developing countries. The presence of foreign direct investment in the domestic market will provide a stable demand for the domestic input market. The probable advantages of the FDI on host country are; it facilitates the exploitation of domestic raw materials, it will introduces modern techniques of management and marketing, eases the entrance to new technologies, foreign inflows can also be used for financing current account deficits, financial flows in form of FDI do not make repayment of principal and interests and increases the stock of human capital via on the job training. So it is cleared that foreign direct investment has a positive impact on host country productivity. However some of the literature also suggests the negative externality from FDI that FDI create competition in the domestic economy which crowd out some the domestic investment, in this case FDI only replace the domestic production instead of create competition and when the profit out flow of FDI is too high then it will only add a cost to the country. But in the literature it is also conclude that the positive externalities outweigh the negative once and hence FDI seen to a welcome addition to domestic economy. Here the estimated result confirms their positive relationship with total factor productivity of manufacturing sector. The estimated result suggests that a one percent increase in foreign direct investment will increase the manufacturing productivity by 0.211223 percent.

Technology is embodied in capital and the import of intermediate goods and thus the direct import of intermediate good is one of the channels of technological diffusion across countries. Previous empirical work suggests that import of intermediate goods which are embodied highly R & D expenditure from highly technological developed nations can significantly boost the country productivity, but this effect is not same across-firms, a highly skill intensive firm enhance their productivity from import of machinery and intermediate goods compare to low skill intensive firm. Showing learning effects are very important for technological diffusion. The estimated result confirms that, import of machinery and intermediate goods have positive effects on productivity. The finding shows that one percent increase in the imports of intermediate goods and machinery will boost the manufacturing productivity by 0.310118 percent.

The coefficient of the development expenditure by government also came with a positive sign showing that government intervention in the economy to produce public goods has a favorable impact on economy, because some the goods cannot be produced by the private sector like construction of rail, roads, highway and airports etc, the estimated result confirms that, government expenditure raises the manufacturing productivity. If government development expenditure is increased by 1% it will increase the total factor productivity by 0.527369 percent.

It has been declared that financial development and economic openness reduce the distortions in the product market process and enhance TFP growth. This argument is empirically proved those countries that are highly financially developed and have more open trade policies have shown high economic growth rate compare to the countries who have restrictive financial and trade policies. The estimated result confirms the hypothesis of financial development led growth hypothesis, that financial sector development will boost the productivity level of the economy. The result suggests that a one percent increase in financial development will increase the manufacturing productivity by 0.998204.

Error Correction Model:

$\Delta TFP = -2.638696 + 0.389687\Delta(TFP_{t-1}) - 0.048531\Delta(Hc) - 0.101739\Delta(Op) - 0.017934\Delta(FDI) +$
(0.0163) (0.1118) (0.5666) (0.2888) (0.3797)
$0.084538\Delta(IM) + 0.048846\Delta(D.E) - 0.065683\,\Delta(D.E\_1) - 0.395291\Delta(M2) -$
$0.557024ECM2$
(0.0543) (0.0163) (0.0011) (0.0228) (0.0967)

The estimated error correction term is significant at 10 % level of significant, and observed that the ECM term is with negative sign showing the convergence power of the model. The result shows that any disturbance or shock wills not permanently deviates the model from equilibrium path. It also justify that the functional form of the model is correct. The coefficient of the error correction term is − 0.557024 indicates high adjustment process. About 56% of the disequilibria of the pervious period's shock adjust back to the current period long run equilibrium.

The result further suggests that the short run coefficient of the human capital is with a negative sign and also statistically insignificant. Because educational expenditure is considered as a long term investment and give return and improve productivity in the long run. In short run it just adds a cost to the economy, so it is not surprising that educational expenditure come with a negative sign. The sign of the coefficients of the variables FDI, financial development and openness are also with a negative sign, showing that foreign direct investment and opening the economy to international trade will exert negative effects on productivity. These variables will raise the productivity in the long run through the technological diffusion, knowledge spillover, and elimination of distortion from the product market and as well as from the factor market.

The short run coefficient of the imports of machinery and intermediate goods and development expenditure are according to the prior expectation, showing positive relationship between the manufacturing productivity and development expenditure and imports of intermediate goods and machinery. For diagnostic study see the appendix table 11 to 13. The CUSUM and CUSUMSQ line for manufacturing sector ARDL result are within the boundaries, showing the regression equation is stable. For the plots of CUSUM and CUSUMSQ test see the appendix fig 3 and 4.

4. Summary and Conclusion

The current study is designed to extend the stock of capital series from 1980-2013, which was constructed by Kemal and Ahmad (1992) for the period of (1947-1990). The study is not only limited to total factor productivity measurement, but it also diagnose the productivity response to selected macroeconomic variables such as human capital, transfer of technology, openness of the economy, financial development and development expenditure by government using co-integration technique.

The ARDL and error correction model indicate that the magnitude of elasticity estimate for agriculture sector is quite impressive for all variables. The result of agriculture sector concludes that human capital, openness, development expenditure and the imports of intermediates goods and machinery exert a positive impact on growth in productivity or on TFP. While the share of FDI is although positive but have low elasticity with respect total factor productivity, but surprisingly the coefficient of the financial development come with a negative sign. It is due to credit availability to agricultural sector and hurdle faced by former access to agricultural credit. The coefficient of the ECM function is occur with a negative sign showing the convergence power of the model, that 50% of disequilibria of the previous period's shock adjusting back to the period equilibrium. A stable long-run relationship between the selected variables and productivity growth is found, showing through CUSUM and CUSUMSQ stability tests.

The manufacturing sector result of ARLD and error correction model showing a strong relationship between the dependent and independent variables. The elasticity of estimate for manufacturing sector is very impressive for variables. All the signs of the coefficient are according to the prior expectations. Human capital, openness, financial development and development expenditure by government exert a positive impact on total factor productivity growth. While the sign of the coefficients of the variables FDI and imports of intermediate goods are also positive and have moderate elasticities. The coefficient of the ECM function is occur with a negative sign showing the convergence power of the model, that 55% of disequilibria of the previous period's shock adjusting back to the current period equilibrium. A stable long-run relationship between the selected variables and productivity growth is found, showing through CUSUM and CUSUMSQ stability tests.

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APPENDIX A

Table 1 Dependent variable DTFP:ARDL Results for Agriculture sector result

Variable	Coefficient	Std. Error	t-Statistic
C	5.947*	0.829	7.165
DLDE	-0.160*	0.034	-4.612
DLFDI	0.046*	0.013	3.550
DLHC	0.193*	0.045	4.271
DLIM	0.145*	0.033	4.301
DLIM_1	-0.168*	0.029	-5.698
DLM2	-0.390*	0.089	-4.343
DLM2_2	0.283*	0.082	3.421
DLM2_1	0.556*	0.089	6.205
DLOPENS	-0.188*	0.055	-3.382
DTFP_1	-0.363*	0.118	-3.078
TFP_1	-0.656*	0.136	-4.802
LD_E_1	0.374*	0.044	8.495
LFDI_1	0.087*	0.021	4.058
LIMP_1	0.299*	0.046	6.501
LM2_1	-0.894*	0.158	-5.652
LOPENNESS_1	0.402*	0.064	6.238
LHC_1	0.228*	0.041	5.512

Table 2	**Pesaran et al. value for F-statistics**	
Critical value	Lower bound value	Upper bound value
1%	3.15	4.43
5%	2.45	3.61
10%	2.12	3.23

Table 3	**Test summery**		
Wald restriction test	14.4655 prob, (0.000)	R^2	.8757
Durbin-Watson stat	1.9363	Adjusted R^2	0.7701
F-statistics of ARDL	8.2825 prob, (0.000)		

Table 4	**Robustness of the Model and Diagnostic Checking**	
Breush- Godfrey Serial Correlation LM test	0.020077	Prob, (0.8873)
Jacque-Bera Normality test	2.473146	Prob, (0.2909)
Hetroskasticity: Breusch-Pagan-Godfrey test;	3.384089	Prob, (0.9998)
Hetroskasticity: ARCH test;	0.092228	Prob, (0.7614)

Table 5	**ECM RESULT OF AGRICULTURE SECTOR**		
Variable	Coefficient	Std. Error	t-Statistic
C	6.604910	0.910158	7.256885
DTFP_1	-0.399027	0.120737	-3.304923
DLIM	0.140338	0.034122	4.112821
DLIM_1	-0.173279	0.029717	-5.830980
DLM2	-0.434827	0.094568	-4.598045
DLM2_1	0.628228	0.100359	6.259810
DLM2_2	0.341384	0.090347	3.778604
DLHc	0.201563	0.046371	4.346780
DLOp	-0.220130	0.059717	-3.686224
DLFDI	0.055288	0.013971	3.957392
DLD.E	0.161092	0.035179	4.579171
ECM1	-0.497083	0.283901	-1.750901

Table 6	**Test summery**		
F-statistics	8.0492 (0.00039)	R^2	0.9848
Durbin-Watson stat	2.2451	Adjusted R^2	0.7838

Table 7	**Robustness of the Model and Diagnostic Checking**	
Breush- Godfrey LM test	1.767833	Prob, (0.8873)
Jacque-Bera Normality test	0.8908	Prob, (0.2909)
Hetro: Breusch-Pagan-Godfrey test;	17.40405	Prob, (0.9998)
Hetroskasticity: ARCH test;	0.092228	Prob, (0.7614)
Ramsey RESET test/ specification test:	0.140311	Prob, (0.7080)

Figure 1. CUSUM

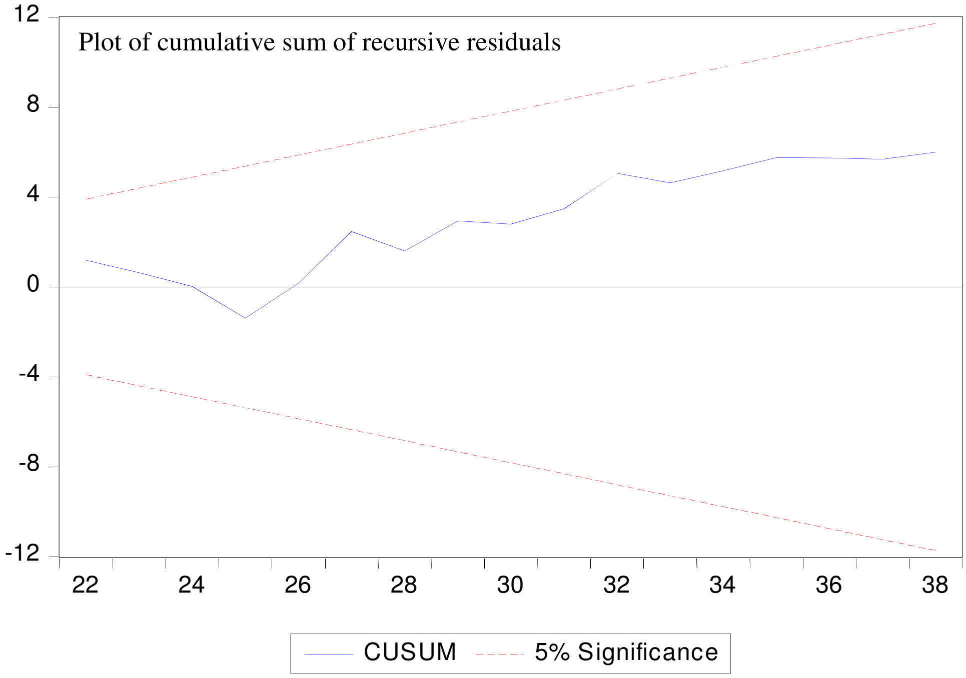


Fig 2. CUSUMSQ,

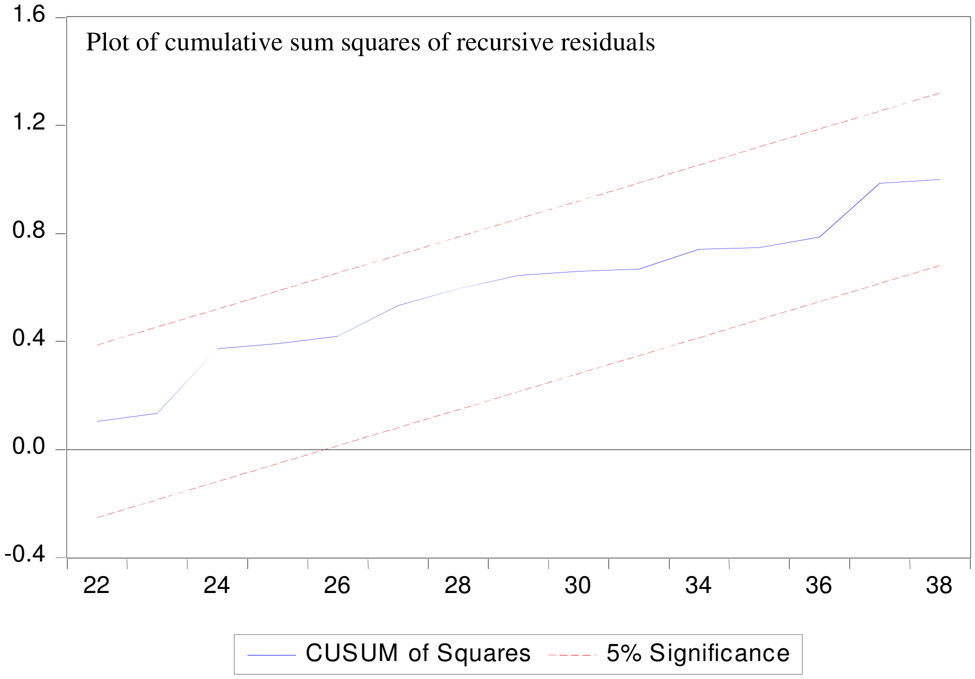


Table 8. Depended variable is DTFP: ARDL Result for Manufacturing Sector			
Variable	Coefficient	Std. Error	t-Statistic
C	-2.565173*	1.034787	-2.478938
TFP_1	-0.316183*	0.080788	-3.913708
LIM_1	0.098054*	0.032713	2.997409
LOP_1	0.143223***	0.080429	1.780733
LM2_1	0.315615**	0.154344	2.044876
LHC_1	0.173018**	0.070328	2.460172
LFDI_1	0.066785***	0.033881	1.971157
LD.E_1	0.166745*	0.039942	4.174691
DTFP_1	0.106458	0.178268	0.597182
DLIM	0.079360***	0.042237	1.878921
DLOP	-0.157749***	0.089694	-1.758747
DLM2	-0.343310**	0.146860	-2.337671
DLHC	-0.106709	0.076502	-1.394850
DLFDI	-0.009350	0.019971	-0.468153
DLD.E_1	-0.067909**	0.024652	-2.754683
DLD.E	0.051614*	0.012780	4.038762

Table 9	**Test Summery**		
Wald restriction test	6.6948 prob,0.0006]	R^2	0.773597
Durbin-Watson stat	2.030597	Adjusted R^2	0.555955
F-statistics of ARDL	4.0883prob,(0.001459)		

Table 10 Robustness of the Model and Diagnostic Checking		
Breush- Godfrey Serial Correlation LM test	0.11910	Prob, [0.9086]
Jacque-Bera Normality test	0.758489	Prob, [0.6843]
Hetroskasticity: Breusch-Pagan-Godfrey test;	7.40405	Prob, [0.4955]
Hetroskasticity: ARCH test;	0.060997	Prob, [0.8049]
Ramsey RESET test/ specification test:	1.648672	Prob, [0.2131]

Table 11 The result of the error correction model			
Variable	Coefficient	Std. Error	t-Statistic
C	-2.638696	1.006583	-2.621440
DLD.E	0.048846	0.012839	3.804389
DLD.E1	-0.065683	0.024174	-2.717080
DLFDI	-0.017934	0.019966	-0.898262
DLHc	-0.048531	0.083286	-0.582703
DLM2	-0.395291	0.160211	-2.467313
DLOp	-0.101739	0.093372	-1.089603
DLIM	0.084538	0.041359	2.044010
DTFP_1	0.389687	0.234274	1.663384
ECM	-0.557024	0.319606	-1.742847

Table 12	**Test summery**		
F-statistics	4.265424 (0.001400)	R^2	0.773363
Durbin-Watson stat	1.995872	Adjusted R^2	0.592053

Table 14	**Robustness of the Model and Diagnostic Checking**	
Breush- Godfrey Serial Correlation LM test	0.964826	Prob, [0.6173]
Jacque-Bera Normality test	1.274899	Prob, [0.5286]
Hetroskasticity: Breusch-Pagan-Godfrey test;	5.40405	Prob, [0.3705]
Hetroskasticity: ARCH test;	0.020483	Prob, [0.8870]
Ramsey RESET test/ specification test:	0.250964	Prob, [0.6222]

Fig 3 CUSUMS

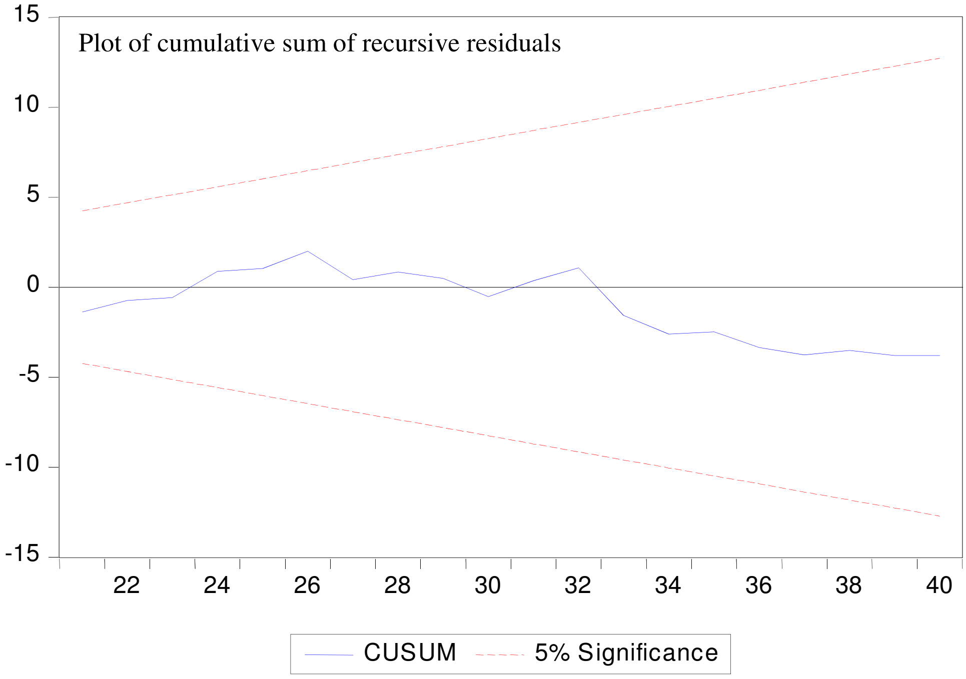
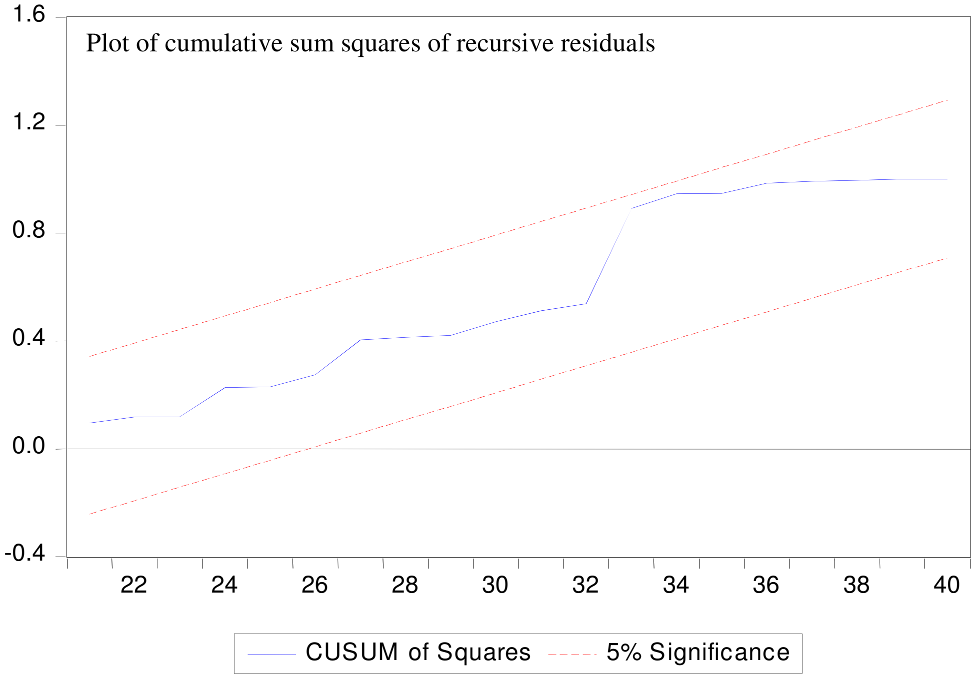


Fig 4 CUSUMQ



Appendix B

Method of generating capital stock

$K_{(t)} = I_{(t)} + (1 - \delta)K_{(t)-1}$ (1)

Where $K_{(t)}$ is the current period capital stock, $I_{(t)}$ is the gross investment level in the current period, δ is the depreciation rate of capital. The gross fixed capital formation will be used for gross investment. The only challenge here is the finding of initial level of capital stock, in order to calculate the initial level of capital stock we need the depreciation rate of capital stock and usually in literature it is taken as 5% but here I will take 4% rate of depreciation because I have to generate the same level of capital stock that are calculated by A. R. Kemal and in his study it is taken as 4% rate of depreciation. And for the current study I will use the initial level of capital stock constructed by Kemal. But the formula of to calculate the initial capital stock is under

$K(t) = {}^{I(t)}/_{\delta} + g$ (2)

The equation 13 implies the possibility of the recursive substitution back in time. For example if rewrite the equation in t-1 period then, we have

$K_{(t-1)} = I_{(t-1)} + (1 - \delta)K_{(t)-2}$ (3)

Now putting equation 15 into equation 13 we get,

$K_{(t)} = I_{(t)} + (1 - \delta)I_{(t-1)} + (1 - \delta)K_{(t)-2}$ (4)

If we continue the similar substitution we get,

$K_{(t)} = \sum_{i=0}^{n-1}(1 - \delta)^{i}I_{(t-1)} + (1 - \delta)^{n}K_{(t)-2}$ (5)

Where n is the fixed moment in time from which the initial capital stock have been calculated, and as n getting high value the initial capital stock will depreciate and will come near to zero.