Journal of Management and Social Sciences
Vol. 2, No. 1, (Spring 2006) 69-81

Labor Productivity and Economic Growth, What Causes What: An Empirical Analysis

Muhammad Mahmud*
Dean,
Faculty of Management Science, KASBIT

Abdul Rashid*
Department of Economics, Institute of Business Management

ABSTRACT

The paper assesses the dynamic association between output growth and labor productivity growth rates using annual data of the period from 1972-73 to 2004-05. The estimates, based on Johansen full-information maximum likelihood technique, indicate that both the rates are cointegrated and move together in the long run. These results are robust to different lag orders. The study then used error correction model to explore the long run as well as short run causal linkages between them. Regarding the long run causation, the estimates of error correction term indicate a unidirectional causation that runs from labor productivity growth rate to output growth. This piece of evidence is suggesting that improving labor productivity would result higher economic growth in Pakistan. Regarding short run causality relationship, the analysis provides evidence based on the estimated F-values that there is feedback association between the rates of economic growth and labor productivity growth.

JEL Classification : D24; J24; O49

Keywords : economic growth, labor productivity, poverty level, human capital.

1) INTRODUCTION

The link between growth in factor productivity and growth of output has received considerable attention particularly from analytical and policy perspective in both

---

* The material presented by the authors does not necessarily portray the viewpoint of the editors and the management of the Institute of Business and Technology (BIZTEK) or KASBIT or Institute of Business Management

* Muhammad Mahmud email :mmahmud77@yahoo.com
* Abdul Rashid email :arahmad_pk@yahoo.com

© JMSS is published by Institute of Business and Technology (BIZTEK).
Ibrahim Hydri Road, Korangi Creek, Karachi-75190, Pakistan.

developed and developing countries. The question between the lines is that whether rapid growth consistently depends partly or whether it is largely accounted by factor accumulation or by growth in efficiency of input use or total factor productivity (TFP). The rapid growth of output in East Asian economies and now recently the uprising trend in growth not only in several countries including South Asian economies, particularly Pakistan and Indian, but also the world economy as a whole due to information and technology revolution has attracted the attention of several economists. The most important are Krugman (1994), Young (1995, 2000), Jorgenson (1995), Jorgenson and Vu (2005) and Jorgenson et al. (2005). It is not, therefore, surprising that several economists are keen to explore the dynamics interaction between growth in factor productivity and growth of output.

Economists argue that there are only two paths by which an economy may increase its level of economic growth: either through more labor effort applied in the production process (specifically, more jobs) or through an increase in the productivity of the workforce. Labor force growth slows and unemployment remains at relatively low levels, then states must increasingly look to productivity enhancements in order to maintain the high rates of output and income growth that have become commonplace over the past few decades. Along with others, a well functioning labor market is an essential element/factor for increasing the productivity of labor and can play a critical role in stimulating growth and poverty reduction. In sum, as said by Krugman "Productivity is not everything, but in the long run it is almost everything"

Jorgenson and Vu (2005) analyzed growth in GDP and TFP during 1989-1995 and 1995-2003. The study uses a sophisticated growth accounting methodology to careful measurement of GDP and factor inputs for the economies of South Asia. They reported that Pakistan experienced a significant decline not only in growth of output but also in total factor productivity in the second period. Similarly, the study by Mahmood and Siddiqui (2000) found that the growth slow down in Pakistan manufacturing (particularly the large-scale units) since the late 1980's is explained by a slow down in total factor productivity (TFP).

Another study by Kemal et al. (2002) also reports that the per year growth rate of output was low in those decades when total factor productivity (TFP) growth rate was low. The empirical findings of these studies clearly provided evidence about the association between output growth and productivity growth rate. In addition, as said by Srinivasan (2005), there is two-way causation between productivity growth and economic growth.

The main purpose of this study is to investigate the dynamic association between labor productivity improvement and economic growth in Pakistan. Johansen's co-integration procedure and vector error correction model are used to explore the long run and short run linkages. The knowledge about the existing relationship will provide bases for effective macro-economic policies to achieve a sustainable economic growth. If both the rates are cointegrated and output growth is caused by labor productivity growth rate, then it can be focused to improve factor productivity, particularly labor productivity, to enhance as well as to sustain economic growth rate. Policies should be designed in such a way that would results technological progress, to boost skill level of the labor force (human capital), to reduce the cost of production, to improve the quality of the output, and to make effective and more productive the economic, legal and institutional environment.

Moreover, a rural development strategy should be designed to improve labor productivity in agriculture sector. On the other hand, if growth in output causes to labor productivity, then it should be focused on more growth-oriented investment. Thus, not only higher growth rate can be obtained but also poverty level can be reduced via increasing labor productivity. Therefore, it would be interesting to examine whether there is a long run stable/equilibrium relationship between the said rates. It is also very useful to explore the direction of causation if a long/short run association is found.

The remainder of this paper is outlined as follows: Section 2 offers the definition and measuring labor productivity. Theoretical discussion is presented in Section 3. Section 4 reviews the pervious studies on this topic. In Section 5, the econometric methodologiesare discussed. The empirical results of the study are presented in Section 6. Section 7 summarizes the key finding and concludes.

2) MEASURING LABOR PRODUCTIVITY

Productivity is a measure of efficiency with which resources, both human and material, are converted into goods and services. Faster rate of economic growth can be ensured through accelerated production and higher productivity in all branches of economic activity. The productivity of human resources (labor), being an important input besides land and capital, plays a significant role in determining the overall economic growth of a nation.

As pointed out by Hulten (2000), output per unit input, or total factor productivity, is not a deeply theoretical concept. It is a matter of pure arithmetic to define TFP as the ratio of measure of aggregate output to the measure of input. Several methods are available in literature; however, here a simple and convenient procedure is applied to measure the productivity. The study follows Solow (1957) and the aggregate production with capital and labor as inputs and a Hicks neutral shift parameter *A* as follows:

$$Y = Af\,(L, K)$$

where f is the sign of function and

y :output (real gross domestic product (GDP))

l :labor (the number and hours of people working)
k :the stock of physical capital (plant and equipment)
A :measure of productivity (a higher value of A means that the same inputs lead to more output)

According to this production function, the growth of output depends on an increase in inputs (labor units, and capital stock) and an increase in total factor productivity, "*A*". The above production function can be expressed as:

$$Y = AL^{a} K^{\beta}$$

Then the growth in aggregate output Y is due to growth in total factor productivity, labor and capital stock.

$$\frac{dY}{Y} = \frac{dA}{A} + a\frac{dL}{L} + \beta\frac{dK}{K} \quad (1)$$

where dX / X represent the percentage rate of change of variable X over the period considered e.g., one year: $dX / X = (X_t - X_{t-1}) / X_{t-1}$. Similarly, decomposition of output per worker, labor productivity, is defined, first dividing the production function by labor L and then taking the first derivative with respect to labor.

$$Y / L = AL^{a} K^{\beta} / L$$

$$Y / L = AL^{\ \ 1} K^{\beta}$$

$$\frac{d(Y / L)}{(Y / L)} = \frac{dA}{A} + \quad 1\frac{dL}{L} + \beta\frac{dK}{K}$$

where the left side term is labor productivity growth rate and is defined $d(Y / L) / (Y / L) = dY / Y - dL / L$ and similarly, $d(K / L) / (K / L) = dK / K - dL / L$ is the growth in the amount of capital per worker (K / L). Thus, output per worker, labor productivity, grows because of: (1) growth in total factor productivity, and (2) growth in amount of capital per worker.

3) THEORETICAL DISCUSSION

Several theoretical models explain the interaction between gains in productivity of resources and growth of output. For example, Solow (1957) presents a simplified model of economic growth that serves as the point of departure for the later growth theories. The model specifies a neoclassical production function, where physical capital, labor, and an exogenous technology influence the level of output.

The neoclassical theory of economic growth focused on labor usage and capital accumulation as the main engines of long-run growth. This approach, however, has been unable to explain sustained growth without assuming ongoing productivity growth, because the impact of capital accumulation is limited by diminishing returns for a given labor force; each unit of capital added in the economy will have a smaller marginal improvement on output. Beyond some point, the marginal return on adding new capital will be smaller than the marginal cost of adding new capital. Therefore, growth would stop at this point without increases in productivity.

"New" growth theory, on the other hand, has focused on the ongoing technological change that raises productivity as the main engine of growth. In principle, technological development could lead to sustained long-term growth because the increases in productivity would be enough to offset the decreases in productivity from diminishing returns to capital accumulation. Thus, it can generate growth as a result of the economic structure. Therefore, it is often termed "endogenous growth theory (see Stiroh, 2001, for more on this subject).

4) LITERATURE REVIEW

The productivity and economic growth has been studied extensively but yet remained much debated. The literature of economic growth studies suggests that growth has a strong and positive correlation with productivity. Theoretical and empirical research on the relation between productivity and economic growth has a rather long history dating back to the work of Jorgenson, Gollop and Fraumeni (1987). Economists have found empirical evidence that countries with high productivity tend to grow faster. A large number of studies are available that sufficiently debate the estimation of TFP growth, GPD growth, the determinants of TFP and the contribution of TFP to growth*. However, below the paper reviewed some studies related to this area that examined the relationship between TFP growth and GDP growth.

The results of the study by Jalava (2002) reinforce the view of shift taking place in the Finnish growth pattern after the early 1990s recession, from extensive to intensive growth*. He also concluded that multi-factor productivity (MFP) has been the engine of growth during the whole observation period from 1975 to 1999.

The study by Jorgenson and Vu (2005) examines growth in GDP and TFP during 1989-1995 and 1995-2003 using a sophisticated growth accounting methodology and careful measurement of GDP and factor inputs. More specifically, they analyze the impact of information technology equipment and software on the recent resurgence in world economic growth. Their analysis shows that the contribution of such investment to world GDP growth doubled from 0.27% per year in 1989-95 to 0.53% per year in 1995-2003, while GDP growth rose only by 38% from 2.50% to 3.45%. They concluded that productivity growth contributed by one-fifth of the total during 1989-1995, while input growth accounted for almost four-fifths. Similarly, input growth contributed more than

---

* *For example, among others, Lucas (1988), Alwyn Young (1995), Hall and Jones (1999), Senhadji (2000), Klenow and Rodriguez-Clare (2004), and Srinivasan (2005) provide excellent surveys of the theoretical as well as the empirical literature on this area.*

* *Where extensive growth means growth achieved through investment in capital equipment, whereas intensive growth means that growth is achieved through productivity.*

seventy per cent of growth after 1995, while productivity accounted for less than thirty per cent. They also reported that both GDP growth (5.8% compared to 7.35%), TFP growth (1.72% compared to 3.86%) have been declined in Developing Asia during 1995-2003 as compared to 1989-1995. This piece of finding provides evidence that there is a significant link between TFP growth and growth of output. Regarding Pakistan, their results show that both GDP growth (from 4.10% per year to 3.47% per year) and TFP growth (from 0.76% per year to 0.52% per year) declined during 1995-2003 as compared to 1989-1995.

Mahmood and Siddiqui (2000) focused on manufacturing industries in Pakistan. They used the Solow methodology for estimating TFP during the period 1972-1997. Their study found that the growth slow down in Pakistan's manufacturing since the late 1980's is explained by a slow down in TFP growth. The estimates provide evidence that growth of manufacturing output fell from 9.26 per cent and 6.69 per cent per year respectively during 1980-85 and 1985-90. They also reported that TFP growth declined sharply from 4.84 per cent and 4.29 per cent respectively during 1980-85 and 1985-90 to 1.36 per cent and -1.25 percent respectively during 1990-95 and 1995-97.

Another study has been done by Kemal et al. (2002) in the same area, which covers the period from 1960 to 2000 (broken down by decades). They found that TFP growth has been declined from a peak of 3.39% in the 1960's to a low of 0.78% in the 1990's. As they reported that Pakistan experienced a rise both in the rate of TFP growth (from 0.82 per cent per year to 2.45 per cent per year) and the rate of GDP growth (from 4.66 per cent per year to 6.12 per cent per year) during the 1980's as compared to 1970's. However, during 1990's, both the rate of TFP growth and the rate of GDP growth significantly declined to 0.78% per year and 4.41% per year respectively.

It can be summarized in the light of the above studies that TFP growth is one of the major determinants of GDP growth. Almost all the mentioned studies conclude that TFP growth associated positively with GDP growth. Researchers and policy makers are keen to know the answer of the question "Is this interaction two-way?" The primary objective of this study is to examine whether there is a feedback causal linkages between growth in labor productivity and GDP growth. The main difference between this study and the previous studies is that they mainly focused on estimation of TFP growth and GDP growth. They did not perform any econometric test to explore the long run relationship. Thus, the long run association between growth in GDP and TFP is still mystery. There is need to unfold it that will provide new tasks to policy makers for enhancing economic growth and raising living standards. Unlike most pervious work, here well-known econometric tests are used to examine the time-series properties and long run relationship between labor productivity growth and GDP growth.

5) ECONOMETRIC MODEL

A number of tests are available in literature to examine the long run relationship. In most previous empirical studies, the linkages between the said variables have been examined by using the OLS regression analysis. In this study, we employ Johansen test, which provides more robust results than the OLS regression analysis procedure. Before we proceed to testing cointegration, we begin by testing the time-series properties of the said variables.

A number of the empirical studies in econometrics literature have reported that the classical or conventional non-stationarity test (such as DF, ADF and PP tests) is not very powerful against relevant alternatives. For instant, Delong et al. (1989) found that the Dickey-Fuller tests are not able to reject a unit root null hypothesis against stable autoregressive alternatives with roots close to unity. Similarly, the study by Diebold and Rudebusch (1990) has provided empirical evidence that standard unit root tests also have low power against fractionally integrated alternatives.

To avoid this problem, the present study uses the KPSS (Kwiatowski et al. (1992)

methodology (the LM statistic) to test for the stationarity. Under this method, the null hypothesis is stationarity and the alternative is the presence of a unit root. This ensures that the alternative will be accepted (null rejected) only when there is strong evidence for (against) it. The KPSS test statistic is defined as follows:

$$\acute{\eta} = T^{-2} \sum \frac{S_t^2}{s^2(l)}$$

where S_t is the partial sum process of the residuals are ξ_t from a regression of the respective variable on only intercept in case of level stationary, and on intercept and a trend term in case of trend stationary; that is defined as: $S_t = \sum_{i=1}^{t} \xi_t$

and, $s^2(l) = T^1 \sum_{t=1}^{T} \xi_t + 2T^{-1} \sum_{m=1}^{l} w(m,l) \sum_{t=m+1}^{T} \xi_t \xi_{t-m}$, where $w(m,l)$ is an optional weighting function; this is, $w(m,l) = 1 - m / (1 + l)$, where is the maximum lag order.

Johansen cointegration methodology is used to examine the long-run equilibrium relationship between labor productivity growth and GDP growth. Consider an m-dimensional Vector Autoregressive (VAR) process, with and without trend, is employed to perform the Johansen (1988) test.

$$Y_t = A_1 Y_{t-1} + A_2 Y_{t-2} + \ldots + A_m Y_{t-m} + BZ_t + \Psi_t \quad (2)$$

$$Y_t = \sum_{i=1}^{m} A_i Y_{t-i} + Bz_t + \psi_t$$

where Y_t is a k-vector (n × 1) of I(1) variables*, Z_t is a d-vector (n × 1) of deterministic variables, the matrix B contains the exogenous variables that are excluded from the cointegration space, m is the maximum lag, Ψ_t is assumed to be k-vector (n × 1) of Gaussian error term, and A_i's are (n × n) matrices of coefficients to be estimated. The above vector autoregressive process can be reformulated into a vector-error-correction form:

$$\Delta Y_t = \Pi Y_{t-1} + \Gamma \Delta Y_{t-1} + \Gamma_2 \Delta Y_{t-2} + \ldots + \Gamma_m \Delta Y_{t-m+1} + BZ_t + \psi_t \quad (3)$$

where, $\Pi = -[1 - A_1 - A_2 - \ldots - A_m]$, $\Gamma_i = -[1 - A_1 - A_2 - \ldots - A_i]$ and $(i = 1, 2, \ldots, m - 1)$.The principal difference between equation (2) and equation (3) is that the time paths of cointegrated variables are influenced by the extent of any deviation from long-run equilibrium as well as by their separate self-feedback pattern plus stochastic shocks and exogenous variables. According to the Granger representation theorem, if Π has a reduced rank $r<k$, then there exist $r \times k$ matrices such that $\Pi = \alpha\beta'$, where α represents the speed of adjustment to disequilibrium while β is a matrix of long-run coefficients. Thus, the term $\beta' Y_{t-1}$ is equivalent to the error-correction term.

Johansen's test for cointegration centers on estimating the matrix Π in an unrestricted form and then testing whether Π has less than full rank. The number of the independent cointegrating vectors depends on the rank of Π. Johansen's approach for testing the null hypothesis of no cointegration depends on likelihood ratio, the trace $\{\lambda_{trace(r)}\}$ that is defined as: $\lambda_{trace(r)} = -T \sum_{i=r+1}^{k} ln(1 - \hat{\lambda}_i)$

where T is the number of useable observations, r = 0, 1,…,k – 1, and $\hat{\lambda}_i$ is the i-th largest eigenvalue.

* *In our study Y_t contains domestic output growth and labor productivity growth rates.*

5.1) ERROR CORRECTION MODEL (ECM)

To test the Granger causality, we employed the vector error correction model. It is defined as follows:

$$\Delta Y_t = \Psi_0 + \lambda_0 B_{t-1} + \sum_{i=1}^{p} \beta_{0i} \Delta Y_{t-i} + \sum_{i=1}^{k} {}_{0t} \Delta X_{t-i} + \zeta_{0t} \qquad (4)$$

$$\Delta X_t = \Psi_1 + \lambda_1 B^{*}_{t-1} + \sum_{i=1}^{p} \beta_{1i} \Delta Y_{t-i} + \sum_{i=1}^{k} \eta_{1t} \Delta Y_{t-i} + \zeta_{1t} \qquad (5)$$

where Ä is the first difference operator (i.e.,$\Delta\ Y_t = Y_t - Y_{t-1}$),$\zeta_{it}$ is i.i.d with zero mean and finite variance, and B_{t-1} and B^*_{t-1} are lagged residuals obtained from the following cointegration regression:

$$Y_t = a_0 + b_0 X_t + B_t \qquad (6)$$

$$X_t = a_1 + b_1 X_t + B^*_t \qquad (7)$$

Error-correction models, i.e., equations (4) and (5), can also be used to draw inferences about causality between economic variables. In equation (4), X cause Y if λ_0 is statistically significant (the long-run causality) or the η_{0i}'s are jointly significant (short-run causality). If both $\lambda_0$and λ_1 are statistically significant, this indicates bi-directional long-run causality.

5.2) THE DATA

To explore the long run as well as short run dynamic linkages between output growth rate and labor productivity growth rate, we used annual data over the time span from 1972-73 to 2004-05 for Pakistan's economy. The data on gross domestic product (GDP) and employment level are taken from Pakistan Economic Survey (various issues) prepared by Federal Bureau of Statistic. GDP deflator based on 1980-81 is used to calculate the real GDP (output). The labor productivity is estimated by using the said methodology.

6) EMPIRICAL RESULTS

The average and standard deviation of growth rates of output, employment level and labor productivity are presented in table 1. It can be seen from the table that the average growth rate of output was the highest with magnitude of 6.14% per annum during the 1980s. However, in the 1990s, the per annum growth rate has been declined to 4.43 per cent. This declining trend has been continued and per annum growth rate further declined to 4.36 per cent during the period of 2000-01 to 2004-05. However, it is interesting to note that the growth rate was less volatile during the 1980s relative to other examined periods. Over the last five years, the average growth rate of output was 4.36 per cent, which was more volatile as compared to other eras.

Table 1
Growth in Output, Employment Level and Labor Productivity

Years	Output Growth		Growth in Employment Level		Growth in Labor Productivity	
	Average	S.D	Average	S.D	Average	S.D
1972-73 to 1979-80	5.60	2.02	0.033	0.007	3.14	2.56
1980-81 to 1989-90	6.14	1.42	0.023	0.016	3.13	2.25
1990-91 to 1999-00	4.43	1.78	0.021	0.020	1.33	2.77
2000-01 to 2004-05	4.36	2.27	0.022	0.016	2.87	2.52

The per annum growth rate in employment level was not only the highest but also less volatile during the 1970s. In 1980s, the per annum growth in employment level has been declined; however, it has been increased during 2000-01 to 2004-05. Regarding to growth in labor productivity, the table shows some fascinating information. Per annum productivity was highest with magnitude 3.14 during the 1970s. This figure clearly shows a strong association between productivity and output growth rates because in this era output growth rate was also higher relative to other decades. Per annum growth of labor productivity was 1.33 per cent during the 1990s that was the lowest as compared to other periods. This may be one of the major factor/reason that is responsible for low per annum output growth during that era.

Although the per annum labor productivity growth rate has considerably been increased during the last five year yet per annum growth rate has not been increased at the same proportion. Overall, the descriptive statistics are providing some evidence of the linkages between output growth rate and growth rate in labor productivity: a theme that is explored in this study.

The first step involved in applying cointegration is to determine the order of integration of each variable/series. To do this, we performed the KPSS test to test the null of stationary against the alternative of unit root along with the traditional unit root tests both at level and first differences of output growth rate and growth in labor productivity. The ADF and KPSS test statistics are reported in Table 2 and Table 3 respectively.

Table 2
ADF Unit Root Tests

Variables	Lag Truncation Parameter					
	1	2	3	1	2	3
	At Level			At First Differences		
Output Growth	-3.063**	-2.318	-1.690	-5.543*	-4.883*	-3.285*
Labor Productivity	-2.419	-2.345	-2.094	-7.250*	-4.688*	-5.236*

**, ** indicate significant at one and five per cent significance level respectively*

It can be observed from Table 2 that the null hypothesis of a unit root in the level series cannot be rejected in general for both the examined series. However, using a specification with one lag order, we are able to reject the null hypothesis of unit root for output growth rate. It means the series does not follow unit root at level only with one lag order. As can be seen from the table, this rejection however, is not robust to other lag orders. Therefore, it can be concluded that both the said rates are non-stationary in their levels. The table also reports the results of the ADF test for the first differences of the variables. It can be seen from the table that estimated test statistics reject the null hypothesis of non-stationary in favor of the alternative stationary for all the series. Thus, the first differences of all the series appear stationary indicating that all of the variables are integrated of order one.

As mentioned earlier, the ADF test is not able to reject a unit root null hypothesis against stable autoregressive alternative with roots close to unity. This test also has low power against fractionally integrated alternatives. Thus, in this study, we also estimated the KPSS test. This estimated test statistics indicate that both the said series follow unit root at their level. These findings are supporting the ADF test results.

Table 3
KPSS Unit Root Tests
Statistics for Level Stationarity

Variables	Lag Truncation Parameter					
	1	2	3	1	2	3
	At Level			At First Differences		
Output Growth	2.075	1.092	0.659	0.097	0.098	0.151
Labor Productivity	1.921	1.020	0.622	0.059	0.048	0.029

Note: In KPSS tests, the lag orders are used to correct for error autocorrelation. 5 per cent critical value is o.463.

The next step to carry on the cointegration testing procedure is to determine the optimal lag-length and to specify the model. To proceed with this, the Akaike Information Criterion (AIC) was calculated for lags ranging from one to four for all possible cointegration vectors form models with either restricted intercepts and no trends or unrestricted intercepts and restricted trends. The maximum absolute value of the criterion suggests a specification of model with intercept and 2 lags.

Table 4 presents the Johansen trace test to determine the number of cointegration vectors for the specification suggested by the selection criteria and using specification with one and three lags. The estimated statistics using 2 lags strongly support the presence of one cointegration vector for output growth and growth in labor productivity. These findings are robust to 3 lags. However, the results using a specification with intercept and one lag indicate two-cointegration vector for the said growth rates.

Table 2
ADF Unit Root Tests

Variables	Lag Truncation Parameter					
	1	2	3	1	2	3
	At Level			At First Differences		
Output Growth	-3.063**	-2.318	-1.690	-5.543*	-4.883*	-3.285*
Labor Productivity	-2.419	-2.345	-2.094	-7.250*	-4.688*	-5.236*

**, ** indicate significant at one and five per cent significance level respectively*

It can be observed from Table 2 that the null hypothesis of a unit root in the level series cannot be rejected in general for both the examined series. However, using a specification with one lag order, we are able to reject the null hypothesis of unit root for output growth rate. It means the series does not follow unit root at level only with one lag order. As can be seen from the table, this rejection however, is not robust to other lag orders. Therefore, it can be concluded that both the said rates are non-stationary in their levels. The table also reports the results of the ADF test for the first differences of the variables. It can be seen from the table that estimated test statistics reject the null hypothesis of non-stationary in favor of the alternative stationary for all the series. Thus, the first differences of all the series appear stationary indicating that all of the variables are integrated of order one.

As mentioned earlier, the ADF test is not able to reject a unit root null hypothesis against stable autoregressive alternative with roots close to unity. This test also has low power against fractionally integrated alternatives. Thus, in this study, we also estimated the KPSS test. This estimated test statistics indicate that both the said series follow unit root at their level. These findings are supporting the ADF test results.

Table 4
Johansen Cointegration Test Statistics

Hypothesis		Lag 1		Lag 2		Lag 3	
Ho	HA	Eigenvalue	Trace Statistics	Eigenvalue	Trace Statistics	Eigenvalue	Trace Statistics
$r = 0$	$r > 0$	0.469	30.112**	0.441	22.798*	0.607	29.916**
$r \leq 1$	$r > 1$	0.286	10.286*	0.163	5.364	0.093	2.842

**(**) denotes rejection of the hypothesis at 5%(1%) significance level.*

The cointegration analysis shows that the growth rate of output and labor productivity growth rate are cointegrated during the examined period. Based on these findings, we estimated the error correction model using specifications that are selected by AIC to investigate the cause-effect relationship between them. The estimates, are shown in Table 5, provide some fascinating results.

Table 5
Short-run and Long-run Granger Causality Tests

Hypothesis	Lag 1		Lag 2		Lag 3	
	Error Correction Term	F-value	Error Correction Term	F-value	Error Correction Term	F-value
GLP does not Granger Cause GOP	-1.071*	45.834*	-1.191*	27.153*	-1.279*	29.118*
GOP does not Granger Cause GLP	-0.848**	0.561	-0.799	5.021**	-1.008	8.543**

where GLP is the growth rate in labor productivity and GOP is the rate of growth in output.
**(**) denotes rejection of the hypothesis at 5%(1%) significance..*

In a specification with two lags (selected by AIC), the coefficients on error term show that there is a unidirectional long-run Granger causality between output growth and labor productivity growth rates that runs from labor productivity growth rate to output growth rate. This finding is also robust in a specification with three lags*. It is implies that to enhance as well as to maintain a considerable economic growth rate, it is necessary to improve the labor productivity through making a effective development strategy to increase the quality of education, to develop a well functioning labor market that can play a critical role in improvement of productivity, to create a good quality job both in the formal/organized and informal sector.

To assess the short-run Granger causality, we estimate the F-statistic in different specifications. Using a specification with two lags (selected by AIC), we found evidence that output growth rate is not only caused by but also causes to labor productivity growth rate in the short run. Thus, it can be concluded that there is a bi-directional causal linkages between them. This finding is also conformed by using a specification with three lags. However, we are able to find unidirectional causality that runs from labor productivity growth rate to output growth rate, in a specification with one lag.

7) CONCLUDING REMARKS AND POLICY IMPLICATIONS

Our intention in this paper was to investigate the long run and short-run dynamics between output growth rate and labor productivity growth rate. The study used annual data for a thirty-three year period from 1972-73 to 2004-05.

** The estimates on error correction term in a specification with one lag indicate that there is two-way causality between output and labor productivity growth rates; however, this evidence is not consistent to other examined lag orders*

To assess the long run equilibrium relationship, we used the Johansen cointegration methodology, to test the null of no cointegration against alternative of cointegration, in different specifications that are selected by AIC. To look at the short run dynamics, we estimate the error correction models in different specifications. The following conclusions have been derived from the analysis:

First, the descriptive statistics provided evidence about the linkages of output growth and labor productivity growth rate. After over two decade of high productivity growth in the 1970s and 1980s, we observed a significant slowdown of productivity growth in the 1990s. We see the same thing about growth rate in output during these periods. However, during the last five years (from 2000-01 to 2004-05), the labor productivity has been grown at a 2.87% yearly rate. We observed that the output growth rate was higher only during those eras when labor productivity was also higher. There are many causes of productivity slowdown. Some of them are: (1) Low rate of public investment in infrastructures. It was 7.5 per cent of GDP during the 1990s that was 9.2 per cent of GDP during the 1980s. (2) Low total fixed investment and national saving during the 1990s. National saving was 13.4 per cent per year during the 1990s that was less one per cent as compared to the 1980s. (3) Less development expenditures as percentage of GDP during the 1990s. It was 4.7 per cent per year in the 1990s as compared to 7.3 per cent during the previous era*.(4) Decline in quality education and health facilities. (5) The energy crisis in the 1990s.

Secondly, using the KPSS unit root tests along with the ADF unit root tests in a specification with 1 to 3 lags, we unable to reject the null hypothesis of a unit root in the levels generally for all the said variables in their levels.

Thirdly, found an evidence of a long-run relationship between output growth rate and labor productivity growth rate. This empirical piece of evidence is robust to the study by Jalava (2002), which postulates that factor productivity has significant positive impact on economic growth. It is also found that these results are consistent to different lag order.

Fourthly, using specifications selected by AIC with only intercept term, it was found that there is a unidirectional causality relationship between output growth and labor productivity growth rate in the long run. This one-way causality runs from the growth rate of labor productivity to output growth rate. The unidirectional causality relationship suggests that an improvement in labor productivity results faster output growth in the long run. These findings are supporting the "New" growth theory, which states that ongoing improvement in productivity is the main engine of growth.

Finally, the calculated F-statistics indicate that there is two-way short run causality association between output growth and labor productivity growth rates. A possible explanation of this finding is that an increase in public investment on infrastructure, improve the quality of education and health facilities, reduce the cost of production and use the higher level of technology result higher and sustainable economic growth rate on one hand and on other hand enhance the labor productivity.

In conclusion, the findings of analysis are suggesting that a substantial long run economic growth can be achieved by ongoing increasing labor productivity. Our investigate shows that an increase in labor productivity leads to an increase in output growth. Thus, an effective workforce training system should be developed to enhance the labor productivity via increasing the skill of working force. Since greater workforce productivity benefits both business and government, the two entities should work more closely together in an effort to provide training for willing workers. Skills partnerships between industry, education centers, and governments should build up not only to enhance the productivity of existing labor force but also to provide more effective and skilled labor to industries. Either through skills partnerships, support of technological advancements, or through other means, policy makers must turn their attention to increase the productivity of Pakistani labor force.

** Source: Pakistan Economic Survey. .*

Moreover, the productivity can be increased in agriculture sector by overcoming water shortage through investment in water infrastructure, encouraging corporate agriculture farming, improving goods market mechanism, creating a labor friendly business environment and above all by establishing a well functional labor market. Government should assist in the promotion of the new technologies because the advance technology ultimately results higher labor productivity. Another area that should be focused is the movement of the workface from low to high productivity activities, both on an inter-regional and inter-industry basis. Labor productivity can also be improved by reducing working time and by setting high minimum wages that on one hand stimulate to persons for work more even in less time and on the other hand keep less productive persons out of employment, raising productivity levels through a composition effect.

Finally, along with government, it is important to recognize that business sector productivity is primarily the responsibility of the business sector. Government creates a favorable framework for business to improve productivity. However, it is the business sector itself, through its own actions, which determines productivity growth in its sector. Business decisions concerning investment, innovation and human capital, the three key productivity drivers, largely determine business sector productivity growth.

REFERENCE

ABRAMOWITZ, M. (1956), "Resource and Output Trends in the United States Since 1870," American Economic Review 46, 5-23.

BARTELSMAN, E. J., AND M. DOMS (2000), "Understanding Productivity: Lesson from Longitudinal Micro Data," Journal of Economic Literature 38, 569-94.

BJORKROTH, T., AND A. KJELLMAN (2000), "Public Capital and Private Sector Productivity – A Finnish Perspective," Finnish Economic Papers 13, 28-44.

DELONG, D. N., J. C. NANKERVIS, N. E. SAVIN, AND C. H. WHITEMAN (1989), "Integrated versus Trend Stationarity in Macroeconomic Time Series," Working Paper No. 89-99, Department of Economics, University of Lowa, Lowa City, IA.

DIEDBOLD, F. X. AND G. D. RUDEBUSCH (1991), "On the Power of Dickey-Fuller Test against Fractional Alternatives," Economics Letter, 35, 155-160.

DOUGLAS W. CAVES, LAURITS R. AND W. E. DIEWERT (1982), "The economic Theory of Index Numbers and the Measurement of Input, Output, and Productivity," Econometria 50, 1393-1414.

DICKEY, D. A. AND W. A. FULLER, (1979), "Distribution of the Estimators for Autoregressive Time Series with A Unit Root," Journal of the American Statistical Association 74, 427- 431.

GROIZARD, J. (2003), "Technology Trade, Productivity and Growth," Working Paper, Universitat de les Illes Balears.

GOVERNMENT OF PAKISTAN, LABOR FORCE SURVEY 2003-04, Federal Bureau of Statistics, Islamabad.

GOVERNMENT OF PAKISTAN, Working Draft, Medium Term Development Framework 2005-10, Planning Commission, Islamabad, March 2005.

HALL, ROBERT AND CHARLES JONES (1999), "Why Do Some Countries Produce So Much More Output Per Worker Than Others," Quarterly Journal of Economics 114, 83-116.

HULTEN, CHARLES R. (2000), "Total Factor Productivity: A Short Biography," NBER Working Paper No. 7471, Cambridge, MA: National Bureau of Economic Research.

JALAVA, J., (2002), "Accounting for Growth and Productivity: Finnish Multi-Factor Productivity 1975-99," Finnish Economic Papers 15, 76-86.

JOHANSEN, S., (1988), "Statistical Analysis of Cointegrating Vectors," Journal of Economic Dynamic and Control 12, 231-254.

JALAVA, J., AND M. POHJOLA (2002), "Economic Growth in the New Economy, Evidence from Advanced Economies," Information economies and Policy 14, 189-210.

JORGENSON, DALE (1995A), "Productivity: Post War United States Economic Growth," Vol. 1, Cambridge, MA: MIT Press

--------------- (1995b), " Productivity: International Comparisons of Economic Growth," Vol. 2, Cambridge, MA: MIT Press.

JORGENSON, DALE AND KHUONG VU (2005), "Information Technology and the World Economy," Scandinavian Fournal of Economics 107, forthcoming.

JORGENSON, DALE, MUNN S. HO, AND KEVIN J. STIROH (2005), "Productivity: Informational Technology and American Growth Resurgence," Vol. 3, Cambridge, MA: MIT Press.

JORGENSON, D. W., F. GOLLOP, AND B. FRAUMENI (1987). "Productivity and U.S. Economic Growth," Cambridge, Massachusetts, Harvard University Press.

KEMAL, A. R. MUSLEH UD DIN AND USMAN QADIR (2002), "Global Research Project: Pakistan Country Report," Pakistan Institute of Development Economics, Islamabad.

KRUGMAN, PAUL (1994), "The Myth of Asia's Miracle," Foreign Affairs, 37, 62-78.

KWIATKOWSKI, D., P. C. B. PHILLIPS, P. SCHMIDT AND Y. SHIN (1992), "Testing the Null Hypothesis of Stationarity against the Alternative of a Unit Root," Journal of Econometrics 54, 159-178.

LUCAS, ROBERT (1988), "On the Mechanics of Economic Development," Journal of Monetary Economics 22, 3-42.

LYNDE, C. AND J. RICHMOND (1992), "The Role of Public Capital in Production," The Review of Economics and Statistics 74, 37-44.

MAHMOOD, ZAFAR AND REHANA SIDDIQUI (2000), "State of Technology and Productivity in Pakistan's Manufacturing Industries: Some Strategic Directions to Build Technological Competence," Pakistan Development Review 39, 1-22.

NORDHAUS, W. (2001), "Alternative Methods for Measuring Productivity Growth," Working Paper 8095, NBER Working Paper Series.

RASHID AMJAD (2005), "Pakistan's Poverty Reduction Strategy: Why Employment Matters," The Lahore Journal of Economics (Special Edition).

SENHADJI, ABDELHAK (2000), "Sources of Economic Growth: An Extensive Growth Accounting Exercise", IMF Staff Papers 47, 129-157.

SOLOW, R. M. (1957), "Technical Changes and the Aggregate Production Function," Review of Economics and Statistics 39, 312-320.

SRINIVASAN, T. N. (2005), "Productivity and Economic Growth," The 21st Annual General Meeting and Conference, Pakistan Society of Development Economists.

YOUNG, ALWYN (2000), "Gold into Base Meals: Productivity Growth in the People's Republic of China During the Reform Period," NBER Working Paper No. W7856, Cambridge, MA: National Bureau of Economic Research.

------------------ (1995), "The Tyranny of Numbers: Confronting the Statistical Realities of the East Asian Growth Experience," Quarterly Journal of Economics 100, 641-680.