International SAMANM Journal of Finance and Accounting
ISSN 2308-2356 January 2014, Vol. 2, No. 1

Productivity Growth and Complementary Assets: An Empirical Analysis of Pakistan

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Abstract:

This paper analyzed the nonlinear relationship between economic productivity and complementary assets of Pakistan. The results indicate that in the long run there are at-least three co-integrating equations. In the second stage of analysis, the rate of change in complementary assets is calculated and regressed on the rate of change in productivity. The results give positive and increasing return to scale for labor and diminishing return to scale for capital formation.

Keyword: *productivity, economics, capital structure, assets..*

Introduction

An economic growth of any country is directly associated with the production of goods and services (GDP) in an economy by using the economic resources of that country. According the standard economic theory, productivity growth in the long run is a primary source of growth in per capita real output and an important measure of economic welfare. In the medium term, growth in labor productivity determines the enhancement in the real output growth. In the analysis of business cycle fluctuations productivity shocks and pro-cyclicality of productivity are distinctively brought under consideration. The empirical analysis revealed that in the long run productivity is dependent on the rate of employment i.e. labor, capital formation i.e. capital stock and Technological innovations i.e. use of modern methods of production, research and development in the business settings. The developing countries have not employed modern methods of production and do not have well developed methods of production. Therefore the area has not been explored in the developing economies. This research will contribute as an empirical support for decision making and policy formation at economic level. The analysis revealed that the complementary assets have positive impact on economic productivity. The employment of labor has greater than unity impact on economic productivity of Pakistan.

Literature Review

The evolution of productivity may also play very important role in the interpretation of development in the macroeconomic variables like inflation and exchange rate in the short run (Acemoglu, Robinson and Johnson, 2000). Productivity growth influences macroeconomic environment where monetary policy of an economy is conducted. Like change in the trend productivity growth potentially affect the derivation of optimal monetary policy. In the real time analysis change in the trend labor productivity growth for monetary policy may vary greatly and is significantly dependent on several factors like strength of response in demand (Alcalá and Ciccone, 2004).

Economic productivity is measured for several purposes; principally it is a measure to compare the economic performance of one country with another. It may be used as an efficiency measure, specifically when applied on an industry. It will help to identify those sectors which are getting worse and those which are expanding rapidly. Labor unions use it for increase in wages when there is an increase in the labor specific productivity. They may claim that in the shape of bonus, profit sharing or other facilities. Another very important element of productivity measure is its use by top managers or shareholders to compare the performance of managers with that of competitors and industry as a whole. Same concept may also be applied in the economies to measure their performance with that of previous government, competing economies or other economies located in the same geography.

Productivity can be examined in terms of factors of productions i.e. labor, capital, and intermediate goods and services i.e. technology, management, and natural resources.

There is a strong link between labor productivity and standard of living, increase in the productivity reduces per unit production cost which reduces price of product and services, general public in and outside the country can afford to buy the product easily. This will increase the demand for product domestically and across the boarders as well. This will enhance the product demand and ultimately production. In order to fulfill this increase in demand, Production units require greater use of equipments and eventually demand for workers. Hence there would be an increase in real wage through increase in employment and will ultimately will improves standards of living. The concept of comparison reveals that there is not a similar

production within the economies. Within an economy there would be disparities in the productivity by regions and industry which will generate differences in standards of living.

Due to different methods used in calculation of productivity index, variations in this measure can hide variations in factors of production other than labor. In the closed economy most of the potential factors which may influence the productivity are related to labor, capital investment including R&D and government regulations (Tawfik and Chauvel, 1980). In an open economic system different other factors enter in the equation like exchange rate and modern technology. The reduction in the value of currency will make the product cheaper in an international market that will ultimately increase demand for product. Oppositely high exchange rate makes the industries competitive through innovation. Higher exchange rate makes the manufacturers obliged to rationalize the production operations and replacement in equipment in order to be competitive internationally (Economic Council of Canada, 1992).

The analysis of Galor and Mountford (2003) suggests that international trade had one sided effect on industrial and nonindustrial evolution in economies, in industrial nations trade gains were towards investment in education section and per capita growth. Additionally significant proportion of trade gains in non industrial nation was channeled towards population growth.

Capital formation is concerned with the saving habits, present income to invest in the future for further output and generation of income. it is usually associated with the acquisition / installation of new machinery, factory equipment and all other productive capital goods. Capital formation may be referred to an increase in the physical investment and domestic public investment which includes investment by government and other public enterprises. Different theories argue that this capital formation plays a vital role in the models of economic growth (Beddies 1999; Gbura and Michael 1996, Gbura, 1997). Gross domestic investment is equivalent to gross fixed capital formation plus net changes in the inventories. Youopoulos and Nugent (1976) called it capital fundamentalism it has been reflected in the macroeconomic performances of different countries. It is evident that even mildly robust growth rates can be sustained over long periods when economies have maintained sizable proportion of capital formation with respect of GDP. According to (Hernandez-Cata 2000) the ratio of capital formation to GDP is the African countries was poor i.e. just 17% in 1990s as compared to 28% in the advanced countries. This phenomenon justifies that there is a strong link between capitalization and economic growth.

The basic tool to measure this link is to calculate ratio of capital formation with gross domestic product. Gillis et al (1987) argue that the fluctuation in the capital formation have significant impact on the economic growth, they further stressed that this ratio should not drop less than 27% in any case and must go as high as 37%.

Capital formation is considered as an important key in the economic growth, recent studies conducted in different parts of world like (Hernandez-Cata (2000), Ndikumana (2000), Ben-David (1998), Collier and Gunning (1999) established a link between capital formation and rate of economic growth.

Investment in information technology improves productivity both at organizational and economic level (Dedrick et al., 2003), there are strong evidences that the returns of technological investment are significantly positive for economy (Jorgenson 2001; Jorgenson and Stiroh, 2000; Oliner and Sichel, 2000; Bosworth and Triplett, 2000) and firms (Brynjolfsson and Hitt, 1996, Lichtenberg, 1995; Dewan and Min, 1997). Research at cross country level indicates that technological investment is associated with significant improvement in productivity for developed countries, which has not been observed in the developing countries (Dewan and Kraemer, 1998, 2000; Pohjola, 2001; Schreyer, 2000).

Despite of lack of significant evidence of productivity results, developing counties have increased their investment in technology dramatically, for example according to Dedrick and Kraemer (1998) in China there are 10 million personal computers were being in use and around 01 million internet users. Now China is the worlds' second largest market for personal computers with sale of around 40 million personal computers in 2009 (Shangguan, 2010). As per report of Internet World Stats (2010) chine is the world’s largest internet user with around 400 million users. Similar rapid growth has been observed in the other places like India, Latin America, Eastern Europe and even South Asia. This state highlighted the need for research to find out whether the investment has started to pay back in higher productivity specifically for developing countries. The results of (Dewan and Kraemer, 1998, 2000; Pohjola, 2001; Schreyer, 2000) indicate that the technological investment has significant productivity gains for developed countries but not for developing countries. Different scholars gave different explanation for non productive gains of information technology. Pohjola (2001) argue that there is a lack of complementary assets such as human capital and telecommunication infrastructure to support this technological advancement. Another explanation given by Dewan and Kraemer (2000) is that the developing countries had not been fully experts for use of technology

effectively, and had not made proper processes, complementary organizational change needed to achieve desired productivity gains.

Moreover it is not recommended to compare the developing countries with the developed countries because of low level of technological stock in the production process.

The value of investment in technology is determined by the availability of complementary assets, which is likely to influence the level of productivity in an economy. One very important resource which supports the use of information technology is the general education level as well as technology specific knowledge and ultimately the human capital. According to Krueger (1993), Bresnahan et al. (2002) Information technology has been considered as a skill biased technology which is closely associated with the skills available to an organization or country. Educated work force can use computer and has flexibility and abilities to pick the use of new technologies (Bartel and Lichtenberg 1987, Robison and Crenshaw 2002). Different studies across the countries have found a strong association between technological investment and education (Shih et al., 2007; Caselli and Coleman, 2001). Kiiski and Pohjola, (2001) pointed out that an education level is significantly important for developing countries rather developed countries.

Methodology & Data Analysis

This segment discusses the structure and strategy to investigate the relationship between different variables of study. The selected research design is experimental research which will combine the theoretical as well as empirical consideration of study.
The study is based on three diverse hypotheses:

01. *There is a long-term relationship between economic productivity and complementary assets*

02. *There is an increasing return to scale for labor employed and economic productivity*

03. *There is an direct and increasing return to scale for capital formation and economic productivity*

Two stage analyses are performed to fine out the productivity payoffs and impact of different complementary assets. Productivity is measured with annual GDP (gross domestic product) and

is hypothesized that it will be affected by complementary assets i.e. capital stock, human capital and technological innovations. The study is comprises on the period of twenty two years i.e. from 1990 to 2011. This period is considered to be sufficient enough to capture the long-term relationship between variables. The time series data is collected from World Bank financial indicators.

Linear production function indicates that productivity denoted as "Y" is dependent upon employment denoted as "L" and capital "K". If data on employment and capital stock is regressed on productivity the regression would give a linear relationship.

$$Y = a_1 L + a_2 K$$

The estimates of a_1 and a_2 will give an estimates of marginal productivity of labor and capital stock for a linear production function. These estimates would be constant, these will not exhibits diminishing returns in productivity as a result of increase in labor and capital.

Productivity is not only dependent on labor and capital employed in an economy or firm, rather there is another important variable which may affect the productivity i.e. use of technology, modern methods of production which sharpen the skills.

Economists have long favored the Cobb-Douglas production function as compare to the linear production function on the grounds that the Cobb-Douglas production function allows for diminishing returns to scale. It allows that level of one input used may affect the productivity level of another input. Cobb-Douglas production function exhibits a nonlinear relationship between inputs, output and two products interact.

$$Y = AL^{a_1} K^{a_2}$$

Therefore to estimate the parameters a_1, a_2 this non linear relationship is required to be linearized.

Technological innovation / modern method of production are also incorporated in the function, the technology is denoted by "A"

This characteristic makes this production function attractive for the economists. The production function is linearized by taking natural log of both sides of equation.

$$\ln(Y) = \ln(A) + a_1 \ln(L) + a_2 \ln(K)$$

Taking natural long of each data series created a new series of variables that are in log level rather than levels.

Mostly time series data has a problem of unit root. Augmented Dickey – Fuller (ADF) test is applied by selecting Schwarz Info Criterion which indicates that the data is non stationary at level, therefore the data is analyzed on first difference and found stationary. It is strongly recommend by the economists that results of ADF should not be relied on and for confirmation Phillips – Perron (PP) may also be applied. Therefore PP is applied by selecting Newey-West Bandwidth and found the similar results. The series are stationary at first difference. The following table exhibits the results:

Table – I

Data Stationary

Variables	Signs	ADF		PP	
		I(0)	**I(1)**	**I(0)**	**I(1)**
GDP	GDP	0.983	(3.688)	1.176	(3.652)
Technology	TEC	(1.581)	(4.115)	(1.671)	(4.124)
Labor	LAB	(0.121)	(3.227)	(0.130)	(3.227)
Capital	CAP	(1.062)	(4.848)	(1.105)	(4.848)
Critical values:					
1% level			(3.447)		(3.447)
5% level			(2.869)		(2.869)
10% level			(2.571)		(2.571)

The data is stationary at first difference; an appropriate tool for checking the long-term relationship among variables is Johanson Cointegration Test.

Unrestricted Cointegration Rank Test

No. of CEs	Eigen value	Trace Statistic	Critical Value	Prob.
None	0.629	41.776	47.85	0.1651
At most 1	0.398	22.933	29.79	0.2494
At most 2	0.326	13.286	15.49	0.1047
At most 3*	0.262	05.789	3.841	0.0161

The results indicate that there are at-least three cointegrated relations or equation in the whole model.

The second criterion for valuation of long-term relationships is to observe Eigen statistic value, the results are presented below:

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

No. of CEs	Eigen value	Max-Eigen Statistic	Critical Value	Prob.
None	0.629	18.843	27.58	0.4267
At most 1	0.398	9.6466	21.13	0.7771
At most 2	0.326	7.4970	14.26	0.4321
At most 3*	0.262	5.7893	3.841	0.0161

The above cited results also support the existence to three cointegrating equations in the model.

In the second stage of analysis growth in productivity as a function of complementary assets is checked by calculating percentage change in variables as compared to the base year. Growth or rate of change in variables is calculated by applying moving average method.

Descriptive statistics

It provides a brief / summarized description of coefficients of given data, and is comprises on central tendency, dispersion and variability. It is very useful in performing empirical analysis. The generated growth series have the following descriptive statistics.

Table –II

Indicators	**Descriptive Statistics**			
	CAP	GDP	LAB	TEC
Mean	16.513	8.472	3.107	45.812
Maximum	70.486	19.118	4.867	497.257
Minimum	(11.444)	(2.221)	0.702	(65.474)
Std. Dev.	17.365	7.539	1.177	116.903
Observations	21	21	21	21

Technological formation has the highest growth rate i.e. 45.81% which moves maximum to 497.26%. Capital formation has second highest average growth rate of 16.51% and maximum growth is 70.48%. The average growth in labor employment is 3.107% which moves maximum to 4.86%. The minimum growth is very low but positive i.e. 0.70% for labor. This situation is very alarming for other two variables, capital formation with a negative growth of 11.44% and Technology has negative growth of 65.47%.

Productivity also has a negative growth of 2.22% and maximum growth is 19.11% with an average growth of 8.47% during the sample period. The highest variability is in the technological formation of 116.9, the second number is of capital formation with a deviation of 17.36, the other variables i.e. employment of labor and productivity has variability of 1.17 and 7.539 respectively.

In the next step of analysis ADF and PP are again applied on the growth series. Which are found to stationary at level, therefore ordinary least square (OLS) may be applied to find an impact on productivity.

Table – III

Data Stationary

Variables	Signs	ADF		PP	
		I(0)	**I(1)**	**I(0)**	**I(1)**
GDP	GDP	(3.699)		(3.663)	
Technology	TEC	(4.323)		(4.323)	
Labor	LAB	(3.218)		(3.218)	
Capital	CAP	(4.920)		(4.923)	
Critical values:					
1% level		(3.447)		(3.447)	
5% level		(2.869)		(2.869)	
10% level		(2.571)		(2.571)	

The generated series are regressed to find out the rate of change in productivity as a result of complementary assets.

$$g_Y = g_A + a_1 g_L + a_2 g_K$$

The new variables can be defined as: g_Y for the growth rate of Y – productivity, g_A, g_L, and g_K for the growth rates of technology, labor, and capital. In the model growth rate of technology is assumed to be constant and regressing the growth variables the derived results are:

$$g_Y = 0.0059 + 1.11\, g_L + 0.2\, g_K$$
$$(0.37) \quad (1.309) \quad (1.726)$$

Growth in employment has positive and increasing return to scale. If there is one unit increase in employment there will be 1.11 units of increase in productivity. Similarly capital formation also has direct relationship but the relationship is decreasing return to scale means one unit increase in capital formation will bring 0.2 units of increase in productivity. The technology is considered to be constant in this model. The value of R^2 is negative because the relationship between productivity and inputs is non linear.

Conclusion

This paper analyzed the role of capital formation, employment and technological advancement in the economic productivity of Pakistan. The nonlinear relationship is analyzed by applying Cobb-Douglas production function. In the process of data analysis ADF and PP test were used to select an appropriate statistical tool to establish the relationship among the variables. The data were stationary at first difference. Therefore cointegratin was applied. The result indicates that there are at-least three integrated equations in the model. Similarly the growth rate in each variable was also calculated and analyzed by applying OLS and found that the there is an increasing return of scale for employment; capital formation has diminishing return to scale. Technology is considered to be constant in both the models. The coefficients of cointegration also revealed increasing return to scale for labor which is consistent with OLS results. As recommend by Gillis et al (1987) the ratio of growth in capital formation should not drop beyond 27% in an economy. In Pakistan during the sample period of 21 years this ratio was less than zero for seven years. There is a consistent decrease in capital formation in the recent years. Therefore it is strongly recommended that this ratio should be increase significantly and should be at-least proportionate to the developed counties. This capital formation may be in the energy sector which will directly support the production capacity of firms and economy will grow ultimately.

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