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Productivity as Base of Economic Growth of Memebr Nations of Saarc

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INTRODUCTION

The member countries of South Asian Association for Regional Cooperation (SAARC) possess similar political, socio–cultural, demographic and economic characteristics. These features, along with the fact that they are neighboring countries, have been one of the main reasons for the formation of this association in 1985. Since then the association has been moving up towards a stronger economic integration by means of Agreements on Preferential Trading in 1993 (SAARC Preferential Trading Arrangement-SAPTA) to the signing of more recent Free Trade Agreement in 2004(South Asian Free Trade Area—SAFTA). The eight member countries of SAARC - Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan, and Sri Lanka—are characterized as the developing nations of South Asia. Apart from the above, these countries have similar resource endowment, usage of similar production techniques and common market for exports. Therefore, these countries offer opportunities for each other's growth as well as also pose competition to each other in terms of common export markets, common exportable commodities and as destination of foreign investment from developed nations.

Resource productivity of a nation is an important driver of growth. Growth of productivity entails induction and use of advance technology, improved organization structures and managerial techniques; but development and/or use of advance technology, improvement in organization structures and managerial techniques; embody better and more educated human capital (Prakash and Balakrishnan, 2008, Sharma, Amit, 2012, Cf. Schultz, 1962, Kothari, 1973, Prakash, 1977). Economic growth of Indian economy has been found to have been driven by the growth of productivity while productivity has grown more on the basis of human capital rather than technology (Prakash and Balakrishnan, 2008, 2010, Sharma, Amit, 2012).

This study focuses on the growth profile of member countries of SAARC. Econometric and statistical models are used to analyze data; Cobb-Douglas and Solow production functions are used to determine the role of labor, capital, and total fator productivity. Inter and Intra country comparisons are made.

1.1 PRODUCTIVITY – CONCEPTUAL BACKGROUND

Productivity is expressed as the ratio of final output to the factors used in production during the specified time. It is calculated as the output per unit of input of labour or capital used to produce that output. The significance of productivity for a nation or production unit lies in the fact that it represents technology used in production at large in an economy on the one hand, and it is an indicator of efficiency of use of inputs in productive processes on the other. Technology in use in current production is an indicator of (i) the nature and quality of inputs/ resources used to produce the desired quantity of final output, (ii) quality of output produced, and (iii) the nature and design and features of the product. Thus the role of inputs/resources used in production play a crucial role in determining the productivity of a production plant and productivity displays the relation between inputs and output. Therefore, level of productivity represents efficiency of resource use. The production process is said to achieve full efficiency when maximum possible output is produced with the current technology and the given amounts of inputs/resources (Diewert and Lawrence, 1999). Achieving maximum efficiency may indicate the best possible utilization of current resources in hand. However, consideration of productivity involves both efficient resource allocation and efficiency of resource use if the technology is given. Technology determines the quantum of inputs required per unit of output. The objective of efficient resource use is either to maximize output produced with the given amount of inputs, or minimize the inputs used in the production of given amount of output.

Growth of output may occur either through factor multiplication process or by factor transformation process. Under the factor multiplication process, more output of the same quality is produced by the use of increased amounts of inputs of the same quality and invariant technology. Output may be produced under constant or increasing/ decreasing returns to scale. Returns to scale, and hence, productivity in this case are determined by the nature of organization structure and techniques of management of production process (Cf. Prakash and Balakrishnan, 2008). But the production function shifts upward to the right. Under the factor transformation process of growth, more output of better quality is produced by the use of smaller amounts of inputs of better quality and advance technology. Generally, efficiency and productivity tend to increase in this case.

1.2 OBJECTIVE

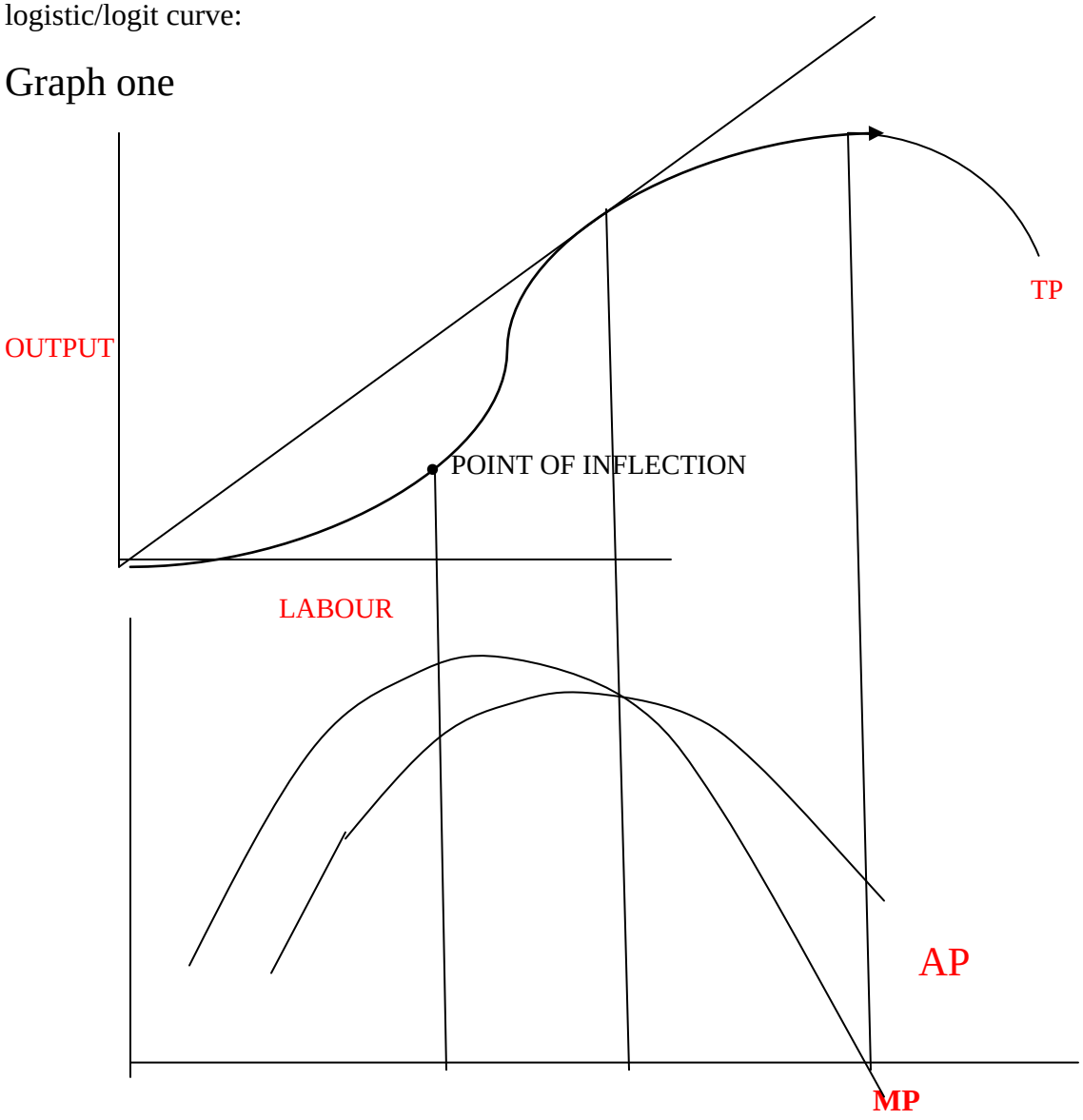
The main objective of the paper is the inter country comparisons of economic growth and productivity. The comparative analysis of the differentials of productivity will highlight the differentials of technology used in production and the differentials of efficiency of resource allocation and their use. Either the total factor productivity of labour or the total factor productivity of capital or both may be considered.

1.3. MEASUREMENT OF PRODUCTIVITY

Generally inputs of labour and/or capital employed in production are considered for the measurement of productivity. Either average or marginal productivity or both may be considered. The choice of the particular measure of productivity depends on the purpose of study. Both

marginal and average productivity are considered in this study. Labor and capital productivity is analyzed separately for each member nation of SAARC. Average factor productivity is the ratio of total output to total labor/capital used in production. Average labor/capital productivity is total output per unit of total labor/capital employed in production of that output. This is the reciprocal of the labor/capital coefficient. Marginal factor productivity is defined as the ratio of incremental output to incremental inputs of labor/capital. Inter-relations between marginal and average productivity are important for analytical purposes and these may be depicted by the following logistic/logit curve:

Graph one



The following are important inter-relations between marginal and average productivities of labor/capital:

(i) The marginal and average productivity curves intersect each other at the peak of the average productivity curve. Therefore, marginal and average productivity equal each other when average productivity has reached its optimum value;

(ii) The average and marginal productivities tend to rise slowly initially but the rate of growth of both average and marginal productivities is accelerated as the level of production increases;

(iii) Marginal productivity rises much more rapidly than the average productivity an it reaches its peak much before the average productivity touches its maximum;

(iv) Marginal productivity begins declining much before the the average productivity starts declining;

(v) Marginal productivity declines much more rapidly than the decline in the average productivity. Both more rapid increase and decrease in marginal than average productivity is the base effect which is a statistical feature;

(vi) But the estimation of marginal productivity entails the constancy of all other factors than labour or capital. Therefore, the constancy of all except one production factors embodies disturbance of optimum factor combination;

(vii) This feature may also be explained by the fact that as the output increases, average cost of production declines though the marginal cost may rise.

Productivity estimates can be employed for some useful purposes. Low and declining marginal/average productivity reflects inefficiency. Therefore, the resource allocation and management of resource utilization requires improvement. Attainment of the maximum level of average productivity indicates that an increase in the scale of production beyond this point entails decreasing returns to scale which may run counter to the objective of production at the lowest cost; or the production of the; maximum output at the given resource cost. This indicates the efficiency/inefficiency of resource use and allocation. Analysis of factor productivity helps in identifying the overall labor/ca-ital requirement to produce the desired level of output in an expansionary phase of the economy. Similarly average capital productivity helps in knowing the total capital requirements to produce the required output at a given technology. Commencement of decline phase of the marginal and average productivity suggests the beginning of the law of decreasing returns or increasing cost of production. Therefore, the productivity helps in the determination of the optimum level of output in the economy or the production establishments. Marginal labor/capital productivity is an important indicator of change in output produced per unit change in labor employed. This implies the inevitability of the marginal wages to decrease and suggests stoppage of further recruitment of labour.

Estimation of both labour and capital productivities are important indicators of factor endowments of member countries of SAARC. These countries are capital scarce and labor abundant. This factor endowment of these countries prompts them to generally use labour intensive techniques of production. This also justifies the low levels of wages. However, the labour intensive techniques of production are of vintages which require replacement of the old by new and more advance capital intensive technology. This feature also induced countries like India to use the import substitution strategy of growth which changed not only its factor endowments in the course of economic growth but it also changed the pattern and composition of trade (Anand, Sonia, 2015, Prakash, Shri and Anand, Sonia, 2015).

However, most of the member countries of SAARC have witnessed huge influx of capital inputs, physical, financial and human, during the recent past, especially after nineties, and a rise in the skills of the labour force. This has been changing the structure of the economies of

these countries. Cob-Douglas (C-D) and Solow production functions are used to derive the estimates of both average and marginal productivities of labour and capital.

1. GROWTH OF OUTPUT, AND PRODUCTIVITY

Traditionally, 'economic growth' has been defined as the process which occurs when people rearrange the available resources in ways that are more valuable to the society. However, modern day economists have defined economic growth as the process which leads to a continuous expansion in output at positive and increasing rate of change over time. A more precise definition states that it is an increase in output of goods and services that is sustained over a long period of time; output is measured in terms of value added. Value added is accounted by the contributions of labour and capital to output net of material goods and services used up in production. That is why C-D model treats net output as a function of labour and capital. But growth involves change in pattern and structure of the economy. Developing economies focus in industrialization as the major strategy of economic growth; it is generally accompanied by the commercialisation of most of the human activities. Large scale structural shifts occur in the economy during the course of growth. (Prakash, S. and Anand, S., 2010). This means that the economy moves away from being largely rural and agriculture based to urban and industry based. The rate of expansion of output of an economy can move it from the status of an underdeveloped to the status of a developed economy. But economic growth is not a discrete short lived once for all change; it is rather a long drawn process involving wide spread changes in an essentially dynamic mode.

Growth of an economy may be categorised into two types: (i) extensive growth and (ii) intensive growth. Extensive growth refers to growth in total output and is extremely significant for examining macro variables like aggregate demand / supply, income, savings rate, investments, nature of trade etc. As against it, intensive growth refers to growth in output per capita which reflects the rising standards of living of the people of the country (Chaudhuri, 1989). This is why Jacob Viner defined a developing economy as one which can maintain its rising population at the current levels of living; alternatively, a developing economy is one which can raise the levels of living of its current population. But the modern view considers growth as that process which can sustain the ever rising standard of living of its changing population over a long period of time.

Importance of economic growth for a country would not be complete without emphasizing the fact that larger range of choices become available to the citizens as a result of economic growth; these choices relate to increasing opportunities of higher and better education to ever increasing proportion of population, better healthcare services, greater number and variety of products, product designs and services for consumption at affordable prices, all of which are the parameters of better and higher standards of living. Therefore, economic growth encompasses higher and better skills, education and knowledge of workforce, more advance and efficient technology of production (Prakash, S. 1977). In the state of under-development, economies are characterised by the coexistence of vintage technologies which are continuously replaced by better and more advance techniques of production (Mathur, P.N., 1962).

2. METHODS AND MODELS

The paper does not depend on the use of one single method or model of data analysis in order to skirt the probability of ending up with otiose type results which may be inbuilt in the method or

model itself. Descriptive statistics is used as a preliminary step to examine the basic features of distribution of values of the variables under study. Mean, median, standard deviation, variance, coefficients of skewness and kurtosis constitute the main tools of descriptive statistical analysis. If it is assumed that the values of the variables under consideration are normally distributed, then the values of mean, median and mode shall be equal. The assumption is used to evaluate the significance of the difference between the mean and median by t statistic:

$t=\{/M-M_e/\}/\sigma$

σ refers to the standard error of the mean. If the calculated value of t>1.96 at 0.05 probability, then the distribution significantly diverges from normality. Consequently, distribution is likely to be positive or negative skew; the distribution will be characterized by inequality in the distribution of the values and substantial degree of concentration of high values in a narrow space around the mode. These facets of the distribution will affect the values of the mean and variance of time series; the assumption of constancy of mean and variances will be violated and the distribution may be affected by non-linear and volatile changes. Consequently, time series of the values of the variable may converge towards non-stationarity which will make the results derived by regression modeling spurious. Therefore, descriptive statistics may be used as a preliminary step for checking non stationarity. Since the study is based on time series analysis, hence, all three versions of Random Walk Model With Drift, Without Drift and With Drift and Stochastic Trend are used in the study. Dickey-Fuller Unit root test is used to rule out non stationarity in the data series. Results of Cob-Douglas function are supplemented by the estimates of Solow production function.

4.2.COBB-DOUGLAS PRODUCTION FUNCTION

The Cobb-Douglas production function is given by the following equation:

$O = f(K, L) = aK^{\alpha}L^{\beta}$ Є……..(1)

O is output, K and L are capital and labour, a, α, and β are positive constants, and Є represents random or errors of estimation.

α + β=1 will hold if production takes place under constant returns to scale; α + β>1 represents increasing and α + β<1 decreasing returns to scale. Thus, Cobb-Douglas function can exhibit any of the above three degrees of returns to scale depending on the values of α + β. But the relation 1 is exponential which cannot be estimated by OLS. But its logarithmic transformation makes the function linear in logarithms:

lnO = lna+αlnK+βlnL+lnЄ…….(2)

α and β in equation 2 are elasticity of output with respect to inputs of capital and labour. As the intercept of regression models generally captures the influence of such important factors on the dependent variable as are important, lna in function 2 may be assumed to represent the influence of technology, structure of organization of production and techniques of managing resource use in production (Cf. Prakash, Shri and Balakrishnan, Bala, 2005).

(do/o)/ (dk/k)=(do/ dk)x(K/O)= α

$(do/ dk)= \alpha(O/K)= \alpha AP$

Where AP depicts average productivity of capital.

These elasticity coefficients can be used to determine marginal productivity in terms of average productivity and vice versa. Substitution of marginal or average productivity from the calculated value from the observations and year on year changes in output, labour and capital will he;p in tracing the productivity curves. This has been done as a part of data analysis in the paper. The sum of two elastic coefficients will furnish insights about the returns to scale and the actual production being convergent or divergent towards the optimum output.

Solow function is the derivative of C-D function. Division of both sides of equation 1 by K yields the following:

$(O/K)= L^{(\beta-1)} Ɛ=aK^{(\alpha-1)} L^{\beta} Ɛ=a (L/K)^{\beta-(\alpha-1)} Ɛ$……(3)

$\ln(O/K)=\ln a+ (\beta-\alpha+1)\ln(L/K)+\ln Ɛ$……...(4)

Functional relation 4 treats logarithm of productivity of capital as a function of labour-capital ratio. There is an ideal level of employment of labour per unit of capital which yields the optimum productivity of capital. Labour productivity may similarly be treated as a function of capital-labour ratio. The functions 3 and 4 are the derivatives of Solow production function.

5. SOURCES OF DATA

The data used for empirical analysis in this study are secondary time series data of seven SAARC countries; data cover the period from 1980 to 2014. Seven SAARC countries are Bangladesh, Nepal, Pakistan, India, Sri Lanka, Maldives, and Bhutan. Afganistan is not included for reasons that are obvious. Data are taken from the “Handbook of Statistics 2013” published by UNCTAD and COMTRADE database, RBI database and Economic Survey, and Ministry of Finance. The main time series used in this study are investment ($million), employment (million), GDP ($million) and population (million) for seven SAARC countries mentioned above.

6. EMPIRICAL ANALYSIS

Results of production function analysis are more often than not affected by multicollinearity because capacity of production depends mainly on capital, especially physical capital; physical capital is represented by machinery and equipment. For the full utilization of physical capital, represented by machinery and equipment, labor and material inputs are to be employed and the required quantities are determined by the coefficients of labor and intermediate inputs. Besides, the estimates of capital and labour productivity, derived from the function are, in fact, the partial productivities, since the elasticity coefficients are partial rather than total.

For the detection of location and magnitude of multicollinearity in the data sets, step wise regression has been followed for each model. Country-wise OLS estimates of the models, specified in the study, are reported below.

6.1 India

Function no.	Dependent Variable	Explanatory Variables	R^2	Alpha coefficient	Beta coefficient	p-value	
1.	Log O_t	Log K_t	0.993	0.238	0.601	3.12E-15	
		Log L_t			0.515	0.004	
2.	Log O_t	Log O_t / K_t	0.988	5.622	-0.179	0.249	
		Log O_t /L_t			1.395	1.11E-16	
3	Log O_t	Log O_t / K_t	0.896	7.159	-2.468	8.51E-18	
4	Log O_t	Log O_t / L_t	0.987	5.503	1.493	4.09E-33	
5	Log O_t	LogΔO_t/Δ K_t	0.064	5.790	-0.143	0.147	
6	Log O_t	LogΔO_t/Δ L_t	0.484	5.502	0.302	4.93E-06	
7	Log O_t	LogΔO_t/Δ K_t	0.5109	5.553	-0.093	0.200	
		LogΔO_t/Δ L_t			0.243	8.57E-06	

Source: Authors' own calculations

Where, O_t = Total output of India measured in $ Millions, K_t = Total absolute investment measured in $ Millions, L_t = Total employment measured in millions, ΔO_t represents change in total output, ΔL_t represents change in total employment and ΔK_t represents change in total investments in India.

Equation 1 of C-D function fits the data well; coefficient of determination has as high a value as 0.993. Thus, 99.3 percent of the total variation in output is explained by the equation. The coefficients of multiple correlation, capital and labor are also positive and significant; values of probability are much less than 0.05 for both the elasticity coefficients. The sum of the estimated values of two elasticity coefficients attached to capital and labour is 1.116. This indicates that the increasing returns to scale are on operation in Indian economy on a general scale. Thus, the production is taking place below the optimum. But output is slightly more responsive to an increase in capital than labor; corresponding to 1% increase in capital when labor remains constant, output increases by 0.60 percent, but 1% increase in employment induces output to rise only by 52%. It indicates a little bit of deficiency in investment relative to employment, Alternatively, it may be inferred that more investment is required per unit of labour than that made at the current level of capital labor ratio. This will also have a direct effect on productivity.

A variant of C-D function is experimented with; logarithm of output is treated as a function of capital and labour productivity separately as well as jointly. Function 4 treats output as a function of labour productivity and it fits the data almost as closely as C-D function. Significant output elasticity with respect to labour productivity shows that corresponding to 1% increase in labour productivity, output rises almost 1.5 times. This is not the case when output is regressed on productivity of capital. Though this function also fits the data well yet the coefficient of determination is much lower than that of functions 1 and 4. Besides, the highly significant elasticity coefficient of productivity of capital is negative. Negativity of this coefficient indicates

that capital-output and labour-capital ratios are below optimum and stagnant; more investment per unit of output and per unit of labour is required in order to exploit the potential of optimum growth of output. The function 2, which treats output as a function of productivity of both capital and labour, also lend support to the above inference. But the coefficient of productivity of capital in this function is not significant but it is negative also. This suggests the existence of multicollinearity in the function. Results of these functions taken together show that (i) output is basically a function of labour and capital at level; (ii) But growth of output of Indian economy is largely productivity driven; (iii) Production is taking place under increasing returns to scale due largely to less than optimum investment. Negative sign attached to the coefficient of productivity of capital in 2nd and 3rd functions suggests near stagnancy of capital productivity; it can be broken by the induction of new technology and investment in physical and human capital.

Functions 5 to 7 treat output as a function of marginal productivity of capital ad marginal productivity of labour. The function 5 does not fit the data well, explained proportion of variation is extremely low, and the regression coefficient is not only negative but it is not significant also.. The marginal productivity of labour is positive as well significant. Functions 6 and 7 fit the data moderately well and marginal productivity of labour is positive and significant, but the negative coefficient of marginal productivity of capital in function 5 and 7 is not statistically significant. Results of these models conform to the results of other models**.**

6.2 SRI LANKA

Sri Lanka is one of the important members of SAARC. The procedure followed is the same as has been followed for India. The following are the estimates of production functions of the economy of Sri Lanka.

	Dependent Variable	Explanatory Variables	R^2	Alpha coefficient	Beta coefficient	p-value	
1.	Log O_t	Log K_t	0.981	6.88	0.325	5.32E-06	
		Log L_t			2.566	3.03E-12	
2.	Log O_t	Log O_t / K_t	0.996	4.18	0.067	0.075	
		Log O_t /L_t			1.350	0.000	
3.	Log O_t	Log$\Delta O_t/\Delta K_t$	0.010	4.214	-0.035	0.710	
		Log$\Delta O_t/\Delta L_t$			0.037	0.618	
4.	Log O_t	Log$\Delta O_t/\Delta K_t$	0.0023	4.236	-0.0024	0.787	
5.	Log O_t	Log$\Delta O_t/\Delta L_t$	0.006	4.208	0.030	0.666	

The Cob Douglas function fits the data well; since the coefficient of determination is as high as 0.981. The function explains98 percent of total variation in output of Sri Lanka, The coefficient of multiple correlation and both the elasticity coefficients of capital and labour are statistically significant.

The function reveals increasing returns to scale in production in the economy; the sum of estimated values of the two coefficients is 2.9. Function 2 also fits the data well since as high proportion of variation as 99.6% of total variations of output is by the function. Average productivities of capital and labour inputs together make output increase 2.9 times the increase in the scale of operations. The coefficient of average capital productivity is positive and significant at 0.075 p-value and the coefficient of average labour productivity is positive and significant at zero p-value. But productivity of labour contributes to the growth of output many times more than the contribution made by productivity of capital. Results imply that (i) Actual output has consistently been lower than the optimum; (ii) Installed capacity of production is under-utilized; and (iii) Labour inputs may be increased till optimum/full capacity output is produced.

6.3 Nepal

The following table contains the results of production function analysis of Nepal.

	Dependent Variable	Explanatory Variables	R^2	Alpha coefficient	Beta coefficient	p-value	
1.	Log O_t	Log K_t	0.979	1.253	0.0016	0.883	
		Log L_t			1.245	7.34E-24	
2.	Log O_t	Log K_t	0.489	3.087	0.224	2.92E-06	
3.	Log O_t	Log L_t	0.979	1.26	1.250	2.22E-29	
4.	Log O_t	Log O_t / K_t	0.784	4.718	-0.030	0.754	
		Log O_t /L_t			3.56	6.29E-11	
5.	Log O_t	Log O_t / L_t	0.783	4.706	3.617	1.63E-12	
6	Log O_t	Log O_t / K_t	0.165	4.043	-0.429	0.015	
7.	Log O_t	Log$\Delta O_t/\Delta K_t$	0.013	3.756	0.052	0.508	
8	Log O_t	Log$\Delta O_t/\Delta L_t$	0.001	3.75	-0.021	0.835	
9	Log O_t	Log$\Delta O_t/\Delta K_t$	0.011	3.744	0.046	0.593	
		Log$\Delta O_t/\Delta L_t$			-0.040	0.715	

Function 1 fits the data well; coefficient of multiple correlation is significant and almost 98 percent of the total variation in the dependent variable is explained by the function. The coefficient of capital is not significant but the coefficient of labour is positive and highly

significant. The non-significance of the coefficient of capital may be due to multicollinearity in the function. This is supported by the fact that the coefficients of capital and labour are significant in bi-variate regression of capital and labour separately. But labour contributes much more to the growth of output than capital. Produvtion in Nepal also takes place under increasing returns to scale. These results may also imply that the techniques of production are labour intensive.

Function 4 and 5 fit the data well and the coefficients of determination are as high as 78 percent. But the sign of the coefficient of average capital productivity is negative but not significant. This may either be due to the multicollinearity in the function or it may also be due to relative stagnancy of investment in the economy. But the coefficient of average labour productivity is positive as well as significant. The estimated coefficient for average capital productivity is significant in the regression of output on productivity of capital which is shown by function 6. This supports the thesis that the non-significance of the coefficient of capital in function 4 is explained by multicollinearity. Remaining functions do not fit the data well.

6.4 Bangladesh

Estimates of different functions for Bangladesh are reported in the table given below.Results

	Dependent Variable	Explanatory Variables	R^2	Alpha coefficient	Beta coefficient	p-value	
1.	Log O_t	Log K_t	0.993	-0.802	0.471	2.9E-07	
		Log L_t			0.756	0.002	
2.	Log O_t	Log O_t / K_t	0.9922	4.978	-0.302	0.010	
		Log O_t /L_t			1.587	3.6E-19	
3.	Log O_t	Log$\Delta O_t/\Delta K_t$	0.833	4.537	-0.023	0.716	
		Log$\Delta O_t/\Delta L_t$			0.624	1.4E-13	
4.	Log O_t	Log$\Delta O_t/\Delta K_t$	0.0039	4.622	0.055	0.7242	
5.	Log O_t	Log$\Delta O_t/\Delta L_t$	0.8328	4.526	0.622	5.65E-14	

Cobb-Douglas function fits the data well. 99 percent of the variation in total output is explained by the production function. The elasticity coefficients of labour and capital inputs are positive and significant. The sum of the elasticity coefficients is 1.227. This shows the prevalence of increasing returns to scale in the production processes of the economy. Output increases by 22.7% more than the increase in the inputs of labour and capital. But the current output is less than the optimum.

The output as a function of average productivities of capital and labour inputs fits the data as well as the C-D function. The elasticity coefficients of output with respect to average

productivities of capital and labour are significant. But the coefficient of average productivity of capital is negative which is accounted by multicollinearity (function 2). The coefficient of marginal productivity of labour is both positive and significant in function 3 as well as 5. These results show that economic growth is basically driven by growth of productivity.

6.5 Bhutan

Estimates of the C-D production function and its modified forms are reported in the following tavle.

	Dependent Variable	Explanatory Variables	R^2	Alpha coefficient	Beta coefficient	p-value	
1.	Log O_t	Log K_t	0.979	0.366	0.562	7.3E-08	
		Log L_t			0.734	0.002	
2.	Log O_t	Log O_t / K_t	0.974	2.251	-0.235	0.100	
		Log O_t /L_t			1.616	1.75E-22	
3.	Log O_t	Log O_t / K_t	0.472	3.557	-2.520	5.05E-06	
4.	Log O_t	Log O_t / L_t	0.971	2.14	1.689	4.03E-27	
5.	Log O_t	Log$\Delta O_t/\Delta K_t$	0.091	2.48	0.036	0.614	
		Log$\Delta O_t/\Delta L_t$			0.248	0.174	
6.	Log O_t	Log$\Delta O_t/\Delta K_t$	0.034	2.59	0.072	0.291	
7.	Log O_t	Log$\Delta O_t/\Delta L_t$	0.083	2.497	0.281	0.096	

Coefficient of determination of C-D function is as high as 0.979; the Cobb-Douglas production function fits the data well as it explains 98 percent of total variation in output. Production is taking place under increasing returns to scale as rge actual output is less than the optimum. But output increases by 29.6 percent more than the increase in the scale of operations, since the sum of two elastic coefficients is 1.296

Function 2 also fits the data well. The elasticity coefficient of the average labour productivity is positive and significant. However, the the elasticity coefficient of average capital productivity is negative and not significant. This may be accounted by multicollinearity. Functions 3 and 4 also fit the data well. The coefficient of average capital productivity is negative but significant and the coefficient of average labour productivity is positive and significant. The negative coefficient of capital may be accounted by stagnancy of stock of capital relative to labour. The operation at optimum scale of output warrants rapid growth of investment relative to growth of employment.

7. t-TEST OF DIFFERENCE OF MEANS OF AVERAGE LABOUR PRODUCTIVITY

Results furnished by empirical estimates of C-D function and its modified forms have shown that (i) Macro Production processes are operated at less than optimum scales in all the member countries of SAARC; (ii) Production is taking place under increasing returns to scale; (iii) Growth of output is largely dominated by the growth of labour productivity; and (iii) Average productivity is not found to be the significant determinant of growth of output due either to multicollinearity and/or stagnancy of capital relative to labour**.**

In view of the above, the significance of the differences between the average productivity of labour of different countries of SAARC are evaluated by the following t-test:Type equation here.

$t = [\text{mean}_1 - \text{mean}_2] / S_{12} * \sqrt{(1/N)}$

$S_{12} = \sqrt{\{(s_1^2 + s_2^2)/N\}}$

The results are reported in the table given below.

	t statistic for difference in means	F statistic of Diff. of variance
India Bangladesh	5.25	2.67
India Nepal	8.39	11.03
India Bhutan	3.70	0.76
India Sri Lanka	4.85	0.70

Calculated values of t0sraristic reported in the above table are consistently greater than the table value of 1.96 at 0.05 probability of significance. The average labour productivity of India is consistently and significantly greater than the corresponding average labour productivity of other member countries of SAARC.

7.1 t-TEST OF DIFFERENCES OF MEANS OF MARGINAL LABOUR PRODUCTIVITY

The calculated values of t statistic of mean differences of marginal labour productivity of members of SAARC are reported in the following table.

	t statistic for difference in means	F statistic
India Bangladesh	2.55	23.16
India Nepal	**2.74**	**68.75**
India Bhutan	**2.15**	**6.58**
India Sri Lanka	**1.90**	**1.15**

The calculated values of t are systematically greater than 1.96 for all pairs but one. The mean difference of marginal productivity of India-Sri Lanka is significant at 0.7 probability. Thus, both average and marginal productivity of labour for India are greater than the corresponding productivities of other SAARC members; these productivity differentials nay explain the differentials of economi growth of these countries.

7.2 T-TEST FOR DIFFERENCE OF MEANS OF AVERAGE CAPITAL PRODUCTIVITY

It often happens that some countries use labour and others use capital intensive techniques of production. Capital intensive technology is labor displacing but labor augmenting. Therefore, it is possible that the differences of means of average and marginal productivities may not be the mirror image of labour productivity. This has prompted the authors to evaluate the significance of differences of means of average and marginal productivities of capital. The results of calculation are reported hereunder.

	t statistic for difference in means	F statistic
India Bangladesh	3.60	0.91
India Nepal	1.88	0.34
India Bhutan	9.44	1.87
India Sri Lanka	0.65	1.78

The above results indicate that the differences of the means of year on year average productivity of capital us significantly different only for India-Bangladesh; fot all other countries average productivities of capital are convergent. This implies that factor endowment of India and Bangladesh are substantially different; but the factor endowment of alkl other members of SAARC are convergent.

7.3 t-TEST FOR DIFFERENCE OF MEANS OF MARGINAL CAPITAL PRODUCTIVITY

	t statistic for difference in means	F statistic
India Bangladesh	1.58	2.42
India Nepal	1.75	2.07
India Bhutan	**2.33**	**2.03**
India Sri Lanka	**1.77**	**0.58**

The calculated values of t depict that the marginal productivities of capital differ significantly between India and Bhutan. But the , Marginal productivities of the rest of the countries are convergent.

The above results are, by and large, in consonance with the results of production function analysis.

7.4 Descriptive statistics

7.4.1 Average Labour Productivity

	India	***Bangladesh***	***Bhutan***	***Nepal***	***Sri Lanka***
Mean	1.529015	0.879277	2.235823	0.553174	2.512455
Standard Error	0.115789	0.043452	0.152398	0.0105	0.166289
Median	1.312562	0.809977	2.292907	0.544735	2.277539
Standard Deviation	0.685016	0.257066	0.901596	0.062116	0.983777
Sample Variance	0.469247	0.066083	0.812876	0.003858	0.967816
Kurtosis	-0.24953	-0.49362	-0.89736	-0.80899	0.01622
Skewness	0.972517	0.78436	0.210814	0.365493	0.930643
Range	2.261738	0.861507	3.010046	0.222915	3.586069
Minimum	0.78018	0.598997	0.852411	0.455363	1.326136
Maximum	3.041918	1.460504	3.862458	0.678278	4.912205
Count	35	35	35	35	35
Coefficient of variation	44.80113014	29.23607	40.32502	11.22902	39.156
t-value for normality	1.869374466	1.594863	-0.37457	0.803714	1.412697

Descriptive statistics for average labour productivity(ALP) has been calculated for five SAARC countries from the period 1980-81 to 2014-15. The series is positively skewed for all the counties. The value of coefficient of skewness being highest for India and Sri Lanka. The coefficient of skewness is quite low in its value for both Bhutan and Nepal. The distribution of this ratio is normally distributed for all of the countries since mean is approximately equal to median in all cases. It is supported by non significant t value in all cases. The coefficient of kurtosis is negative in all cases except one. This suggests very low peakedness of data and mean, median and mode do not seem to be concentrated at one place. This is

supported by Coefficient of variation which is moderately low for all cases. These results indicate that average labour productivity has remained more or less stable over the years for all these countries. It has not shown much fluctuation inter temporally within the respective economy.

7.4.2 Average Capital Productivity

	India	*Bangladesh*	*Bhutan*	*Nepal*	*Sri Lanka*
Mean	3.927888	4.747034	2.295555	4.828833	3.81435
Standard Error	0.152515	0.168541	0.08157	0.454522	0.08552
Median	4.043835	4.500855	2.243058	4.415206	3.804306
Standard Deviation	0.902289	0.997101	0.482576	2.688991	0.505942
Sample Variance	0.814126	0.99421	0.232879	7.230671	0.255978
Kurtosis	-1.13314	-0.27567	-0.78149	9.997697	3.329708
Skewness	-0.05108	0.572672	0.43492	2.858858	-1.07861
Range	2.958142	4.024348	1.740911	15.24855	2.704779
Minimum	2.52672	3.474152	1.575399	0	2.020896
Maximum	5.484862	7.4985	3.31631	15.24855	4.725675
Count	35	35	35	35	35
Coefficient of variation	22.97135254	21.00472	21.02219	55.68615	13.26417
t-test for normality	-0.76023342	1.460648	0.643582	0.910026	0.117446

Descriptive statistics for average capital productivity reveal the distribution for all the countries to be normally distributed due non significance of calculated t value and mean and median values being nearly close to each other in all cases. The coefficient of skewness is negative for both India and Sri Lanka. The distribution is highly positively skewed for Nepal and moderately for Bhutan and Bangladesh. The coefficient of kurtosis is negative for India, Bangladesh and Bhutan and positive for Nepal and Sri Lanka. These results are supported by low value of coefficient of variation for all the countries.

7.4.3 Marginal Labour Productivity

	India	*Bangladesh*	*Bhutan*	*Nepal*	*Sri Lanka*
Mean	15.67447	1.905781	3.961994	0.887886	2.091494
Standard Error	5.398948	0.233101	0.820807	0.078532	4.693652
Median	3.648363	1.665864	3.761907	0.871521	6.342162
Standard Deviation	31.48101	1.3592	4.786085	0.457914	27.36846
Sample Variance	991.0537	1.847423	22.90661	0.209685	749.0327
Kurtosis	5.745389	1.51336	2.886843	2.095762	7.861932
Skewness	2.570163	0.79667	-0.81025	-0.9064	-2.42953
Range	128.1819	7.042196	26.09989	2.238595	143.1877
Minimum	0.191793	-0.91637	-11.7749	-0.55159	-109.37
Maximum	128.3737	6.125827	14.32501	1.687002	33.81815
Sum	532.9318	64.79657	134.7078	30.18812	71.11081
Count	34	34	34	34	34
Coefficient of variation	200.8425803	71.31984	120.7999	51.57351	1308.56
t-value for normality	2.2274908	1.029241	0.243769	0.208386	-0.90562

Descriptive statistics calculated for marginal labour productivity reveals that the ratio is not normally distributed for India since mean is 4.3 times greater than the median value and is supported by a significant t-value. The distribution is normal for all other countries due to non significant t-value. The series is positively skewed for India and Bangladesh and negatively skewed for Bhutan, Nepal and Sri Lanka. The coefficient for kurtosis shows high peakedness for all countries. This is also supported by very high value of coefficient of variation for India, Bhutan and Sri Lanka and moderately high for Bangladesh and Nepal. .

7.4.4 Marginal Capital Productivity

	India	*Bangladesh*	*Bhutan*	*Nepal*	*Sri lanka*
Mean	6.609505	2.410311	0.210888	1.836901	-2.08795
Standard Error	2.466036	1.020659	1.217905	1.194722	4.256947
Median	2.163955	3.107741	0.597724	1.004315	1.71194
Standard Deviation	14.37934	5.951414	7.101546	6.966365	24.82205
Sample Variance	206.7654	35.41933	50.43195	48.53024	616.1342
Kurtosis	14.26594	20.00934	17.25287	10.40828	27.60203
Skewness	3.660848	-4.07068	-3.17461	2.39388	-4.95926
Range	74.76728	36.95652	49.04341	42.61878	168.1379
Minimum	-2.89312	-27.3491	-34.005	-10.8001	-135.952
Maximum	71.87416	9.607408	15.03841	31.81873	32.18593
Sum	224.7232	81.95056	7.170191	62.45465	-70.9902
Count	34	34	34	34	34
Coefficient of variation	217.555475	246.9148	3367.449	379.2455	-1188.82
t-value for normality	1.802710909	-0.68331	-0.31762	0.696887	-0.89263

Descriptive statistics for marginal capital productivity reveals that the distribution is normal for all countries since the t value calculated for difference in mean and median value is not significant for any of the countries. The distribution is positively skewed for India and Nepal but negatively skewed for Bangladesh, Bhutan and Sri Lanka. Coefficient of kurtosis is high for all countries indicating high peakedness of data and concentration of mean, median and mode at closely in the distribution.

7.5 Growth Curves

		Average labour productivity	**Average capital productivity**	**Marginal labour productivity**	**Marginal capital productivity**

Bangladesh	**R^2**	**0.966**	**0.909**	**0.823**	**0.076**
	β coefficient	**0.0113**	**-0.0084**	**0.029**	**0.012**
	p-value	**3.06E-25**	**2.8E-18**	**1.32E-13**	**0.112**
Bhutan	**R^2**	**0.959**	**0.514**	**0.070**	**0.012**
	β coefficient	**0.0184**	**-0.0063**	**0.012**	**-0.015**
	p-value	**1.67E-24**	**1.26E-06**	**0.122**	**0.528**
Sri Lanka	**R^2**	**0.981**	**0.007**	**0.004**	**0.0034**
	β coefficient	**0.015**	**0.00058**	**-0.068**	**-0.003**
	p-value	**3.499E-29**	**0.6189**	**0.70**	**0.789**
India	**R^2**	**0.966**	**0.873**	**0.477**	**0.105**
	β coefficient	**0.017**	**-0.0095**	**0.042**	**-0.016**
	p-value	**5.33E-26**	**2.14E-16**	**6.02E-06**	**0.060**
Nepal	**R^2**	**0.781**	**0.158**	**5.35E-05**	**0.0036**
	β coefficient	**0.0041**	**-0.0075**	**0.00025**	**0.0034**
	p-value	**4.4E-12**	**0.0198**	**0.967**	**0.733**

Source : Author's own calculation

The table above depicts the growth curves calculated for average and marginal capital and labour productivities over a period of thirty four years. The average labour productivity is the ratio of output produced over labour employed in an economy. The ratio has been calculated for the period 1980-81 to 2014-15 for the economy as a whole. The total proportion of variation in average labour productivity over the time period is 96.6 percent for Bangladesh, 95.9 percent for Bhutan, 98.1 percent for Sri Lanka, 96.6 percent for India and 78.1 percent for Nepal. The coefficient of productivity is positive and significant for all the counties. The result indicates that the average labour productivity is increasing for all the countries.

Average capital productivity is the ratio between output produced and capital employed in an economy. Total proportion of variation in the ratio over a period of 34 years is 90.9 percent for Bangladesh, 51.4 percent for Bhutan, 0.7 percent for Sri Lanka, 87.3 percent for India and 15.8 percent for Nepal. The coefficient of average capital productivity is negative and significant for Bangladesh, Bhutan, India and Nepal indicating a decline in capital productivity but rise in overall capital formation. The growth curve in case of Sri Lanka does not seem to fit well due to poor fit of the curve. This may be attributed to the insurgency problem faced by the economy for many years and focus of the government to deal with it rather than on increasing output produced through capital accumulation.

The growth curve for Marginal labour productivity fits very well for Bangladesh but moderately well for India. The total proportion for variation is 82.3 percent for Bangladesh and 47.7 percent for India. The coefficient for both the countries is positive as well as significant indicating increasing marginal labour productivity for the respective country over the years. The curve however, does not fit well for Nepal, Bhutan and Sri Lanka.

The growth curves for marginal capital productivities does not fit well for any country except India due to very poor value of coefficient of determination. The value of coefficient of determination for India is also low showing only 10.5 percent variation in marginal capital productivity over a period of time. The coefficient for it is negative and significant at 0.06 p-value indicating a decline it over the years.

7.6 t- test for difference in means of average and marginal labour and capital productivities between SAARC countries

Formula used : $$t = \frac{\text{mean}_{ALP1} - \text{mean}_{ALP2}}{(SE_{ALP1} + SE_{ALP2})/2}$$

Where ALP1 is Average labour productivity of country 1 and ALP2 is the average labour productivity of country 2.
SE 1 is the standard error term of country 1 and SE 2 is the standard error term of country 2. Same formula has been used for average capital productivity and marginal labour and capital productivities.

Country pairs	**t-value**			
	Average Labour Productivity	**Average Capital Productivity**	**Marginal Labour Productivity**	**Marginal Capital Productivity**
India Bangladesh	**8.176**	**5.125**	**4.889**	**2.408**
India Bhutan	**5.298**	**14.008**	**3.766**	**3.473**
India Sri Lanka	**6.950**	**0.957***	**2.691**	**2.587**
India Nepal	**15.385**	**2.973**	**5.399**	**2.607**
Bangladesh Nepal	**12.074**	**0.260***	**6.532**	**0.517***
Bangladesh Sri Lanka	**15.626**	**7.404**	**0.075***	**1.704***

Bangladesh Bhutan	**13.907**	**19.61**	**3.902**	**1.965***
Bhutan Sri Lanka	**1.742***	**18.301**	**0.678***	**0.839***
Bhutan Nepal	**20.765**	**9.486**	**6.836**	**1.347***
Nepal Sri Lanka	**22.261**	**3.769**	**0.504***	**1.439***

Source : author's own calculations

The calculated values of t statistic reveal the average labour productivities to be significantly different between SAARC countries except Bhutan and Sri Lanka. The average capital productivities significantly differ for all countries pairs except India Sri Lanka and Bangladesh Nepal.

Marginal labour productivity significantly differs for all country pairs except Bangladesh Sri lanka, Bhutan Sri lanka and Nepal Sri lanka. However, marginal capital productivity significantly differs for India Bangladesh, India Sri Lanka, India Bhutan and India Nepal. For others it is not found to be significantly differing with each other. Such result was expected due to focus of the Indian government on implementing the NEP and rapid increase in the output of the economy since 1990.

7.7 t- test for difference in means of average and marginal labour and capital productivities within a country

Formula used : $$t = \frac{\text{mean}_{ALP1} - \text{mean}_{MLP1}}{(SE_{ALP1} + SE_{MLP1})/2}$$

Where ALP1 and MLP 1 refer to the average labour productivity and marginal labour productivity of country 1.

Country	**t- value**	
	Average and Marginal Labour Productivity	**Average And Marginal Capital Productivity**
India	**6.190**	**2.043**
Bangladesh	**7.391**	**3.932**
Sri Lanka	**0.172***	**3.235**
Bhutan	**3.550**	**3.635**
Nepal	**7.590**	**2.716**

The above results depict that Sri Lanka is the only country where average and marginal labour productivities due not differ significantly. This is an indication of the optimum output being produced in

the economy with respect to labour input. However, in other countries this stage is yet to be reached. Similarly, the average and marginal capital productivities significantly differ from each indicating that these economies are not in an equilibrium stage yet.

7.8 Solow production function

$$\frac{O_t}{K_t} = \alpha_0 + \alpha_1 \frac{L_t}{K_t}$$

The OLS estimates of the Solow function are as follows

Country	**R^2**	**α_0**	**α_1**	**p-value**	**d-statistic**
Bangladesh	**0.961**	**0.348**	**0.430**	**3.7E-24**	**0.823**
Nepal	**0.659**	**0.440**	**0.249**	**5.51E-09**	**0.491**
Bhutan	**0.693**	**0.339**	**0.287**	**5.57E-10**	**1.035**
Sri Lanka	**0.136**	**0.547**	**0.140**	**0.029**	**0.586**
India	**0.955**	**0.424**	**0.362**	**6.03E-24**	**0.812**
ENGEL GRANGER ESTIMATES	**R^2**	**α_0**	**α_1**	**p-value**	
Bangladesh	**0.383**	**0**	**-0.5805**	**9.35E-05**	
Nepal	**0.332**	**0**	**-0.408**	**0.0003**	
Bhutan	**0.258**	**0**	**-0.517**	**0.0018**	
Sri Lanka	**0.576**	**0**	**-0.583**	**1.25E-07**	
India	**0.161**	**0**	**-0.391**	**0.016**	

Engel granger test for cointegration has been applied on the data series of all four productivities for the five SAARC countries. The negative and significant value of the slope coefficient in the function indicate the unit root be less than unity for all series for all countries. The time series can thus be considered stationary when used in integration within the same function such as Solow function. Since the errors in the function for all countries was found to be affected with autocorrelation thus, the results of the Solow function corrected for autocorrelation are as follows:

The OLS estimates for Solow function corrected for autocorrelation are as follows:

Country	R^2	α_0	α_1	p-value
Bangladesh	**0.878**	**0.147**	**0.412**	**9.7E-16**
Nepal	**0.932**	**0.198**	**0.283**	**1.15E-19**
Bhutan	**0.887**	**0.0075**	**0.960**	**1E-16**
Sri Lanka	**0.518**	**0.220**	**0.316**	**1.59E-06**
India	**0.753**	**0.074**	**0.472**	**3.03E-11**

The Solow function fits the data well for all the countries since the value of coefficient of determination is high in Bangladesh, Nepal and Bhutan and moderately high for India and Sri Lanka. It shows that high proportion of variation in the dependent variable is explained by the explanatory variable in the function for each country. The coefficient attached with the explanatory variable is positive and significant for all the countries. This shows that capital productivity of each SAARC country is being affected by the labour capital ratio of the country. The factor endowment of SAARC nations lie in labour abundance and hence the production techniques being largely labour intensive. The positive value of the coefficient attached to the labour capital ratio here indicates this. Though capital accumulation has been taking place in these economies through increase in number of foreign direct investments and portfolio investments still the labour capital ratio is high for these countries and they have a long way to go on the path of factor reversability.

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