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TFP Estimation for Pakistan – the Importance of the Collective Infrastructure to Feed the Poor

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Outline

I. Introduction:

Unfortunately, in the world of today the gap between rich and poor is widening. Developed countries are simply more productive. For instance measured in GDP per capita for 2007, very basically assessed, a German on average had in gross terms 47 times "more" to live from than a Pakistani (WORLD BANK, 2008). The gap between the average income of the richest 20 countries and the average for the poorest 20 has doubled in the past 40 years, to more than 30 times (THOMAS et. al, 2001). What are the explanations behind that? In the course of the last century the issue of explaining the radically differential economic performances of countries has attracted international attention. One very promising concept which has evolved in this regard is the concept of Total Factor Productivity, which is frequently used to measure technological advancement and thus competitiveness. Also two important contributions of the 90's by Klenow and Rodriguez-Clare (1997) and Hall and Jones (1999) by utilizing microeconomic evidence on the private returns to physical and human capital have come to the same conclusion that productivity accounts for the majority of cross country income differences. The lead assumption therefore shall be that higher productivity can solve certain issues of developing nations, provided that they are backed by a strong judiciary, civil rights, property rights, good governance, transparency etc. (collective-or social infrastructure). That freedom surely is one crucial prerequisite of progress was recognized by many (Kennedy, 1961). What impact can education and a healthy social infrastructure have on productivity and output in general, this shall be addressed in the course of the upcoming deliberations.

II. The Underlying Empirical Framework for the Analysis of TFP

In order to conduct a TFP Estimation in this paper, the method of non-parametric estimation in the form of growth accounting based on a geometric exact index in line with GHOSH AND KRAAY (2000) has been utilized. Additionally, the method for interpreting the results of the TFP calculation described by KLENOW AND RODRIGUEZ-CLARE (1997) on the basis of growth accounting will be applied to check for differences in assumptions and "testing" methods. Good data availability for the growth accounting method has given the non-parametric approach precedence over the econometric estimation method in this paper. The most obvious limitations of growth accounting which are pointed out by its critiques can be summed up in the difficulties of disentangling technical changes from the effects of scale economies and input substitution. To tackle this issue this paper additionally to the Cobb Douglas production function introduces a Constant Elasticity of Substitution production function (MCFADDEN, 1963), to especially address the issue of input substitutability. Moreover, a sensitivity analysis of the results with regard to the choice of the parameter values will be tested. In following, to include the

contribution of education to Labor input, the size of the labor force and the variable of education will be summarized into one common variable, namely, "human-capital-scaled Labor input" (H). The idea behind using H as an "advanced" Labor input indicator is that standard measures of Labor input based on either hours worked per person or the number of employed persons/-or the size of the labor force are not sufficient for the purpose of this analysis, especially in the case of developing countries where manpower is readily available a qualitative dimension has to be introduced. Applied correspondingly, the above mentioned qualitative dimension is that of "returns to education". Consequently, the production function henceforth also depends on human-capital-scaled Labor input (H) and intends to measure the "returns to education".

Equation 1: The geometric Index of TFP in the Cobb- Douglas Case

$$A = \frac{Y}{\left[K^{\alpha} * H^{1-\alpha)}\right]^{\gamma}} \qquad H = L*D*P*\exp(\phi*S)$$

L=Population;D=Pop.aged 15-64;P=Lab.Force.Partcip.Rate;S=Years of Educ.;Φ=returns of education

So far the assumption has been that the parameters (Y=output, K=capital, H=human-capital-scaled labor input, α=relative importance of capital, γ=extent of returns to scale) of the production function do not change over time. But they might. If, for example, the production function is of the constant elasticity of substitution (CES) type with an elasticity different from 1, the weight on capital can change over time, depending on the size of the elasticity of substitution and the rate at which K grows relative to H. This effect will also be discussed and exemplified in the upcoming deliberations for some plausible values of the elasticity of substitution between physical and human capital (σ). Similar to the Cobb-Douglas case, it is possible to construct a geometric index of TFP to obtain the annual TFP –index measure, as follows:

Equation 2: The geometric index of TFP in the (CES) case

$$A = \frac{Y}{\left[\alpha * K^{\rho} + (1-\alpha)* H^{(1-\alpha)}\right]^{\left(\frac{1}{\rho}\right)}}$$

where ρ (rho) is the elasticity of substitution between K and H. The elasticity of substitution decomposes as follows, ρ= sigma-1/sigma (ρ = σ-1/ σ). When sigma = 1 this reduces to the Cobb-Douglas case above with gamma = 1. The most important thing to understand is that, since *A (TFP)* is not a pure number, it carries no interesting information in itself. But changes in the number indicate shifts in the relation between measured aggregate inputs and Outputs and in this aggregate model these changes are assumed to be caused by changes in technology and changes in efficiency and/or in the scale of operations of countries. TFP growth can be written as growth in Output less a weighted average of growth in inputs, as follows:

Equation 3: The growth rate of TFP

$$gA = gY - \gamma\left[\alpha\ gK + (1-\alpha)\ gH\right]$$

where gA is the growth rate of TFP, gY is the growth rate of Output (GDP), gK is the growth rate of Capital input, gH is the growth rate of human-capital-scaled Labor input, α is a parameter that measures the relative importance of capital, γ is a parameter that measures the extent of returns to scale.

III. The Data Construction for Growth Accounting

To estimate the level and growth rate of TFP (A), data on Output (Y), Capital (K), Population (L), share of the Population aged 15-64 (D), Labor Force Participation rates (P), and stock of years of education (S) was required. In this regard, some important explanations shall follow.

a. Measure of Output (Y):

Because the present paper intends to compare developments over time, namely from 1960 -2004, it seems highly plausible to use GDP on constant PPP basis to measure Output (OECD STATISTICS DIRECTORATE, 2008). The Output data used, was acquired from the PENN WORLD TABLES 6.2 (SUMMERS AND HESTON, 2008).

b. Measures of Input:

Human -capital scaled -Labor (H):

To give the measure of Labor input a qualitative aspect, hence data on human capital is needed. This issue was solved by using data on the physical stock of years of education found in the study by VIKRAM AND DHARESHWARM (1993). To measure the outcome of education or the returns to education, the parameter phi, will be utilized. The parameter phi, which measures the returns to education (the percentage increase in worker productivity due to an additional year of education) by many renowned researchers is assumed to be 0.1 or 10 percent, this in other words means, that up to a point, every additional year of schooling will likely raise an individual's productivity measured in "earnings" about 10 percent. (KRUEGER, 2002).

Capital (K):

In general, data on capital stock is very seldom directly available, even in economies that are well documented, a problem that has been mentioned by many economists (COLLINS AND BOSWORTH, 1996). Fortunately, Capital stocks can be constructed using the Perpetual Inventory Method, which produces annual estimates of gross and net capital stock at constant and current prices by accumulating past flows of expenditure on Investments (NEHRING et. al, 2001). The construction of the capital stock in this way requires information on the initial capital-Output ratio in 1960 (ky0), depreciation rates (delta), and gross domestic investment in constant U.S. dollars adjusted for differences in PPP, for our Output is also measured on basis of PPP. For most developing countries reasonable values range between ky0=1 and ky0=2 according to

GHOSH AND KRAAY (2000), nevertheless for accuracy in results on the basis of ICOR (Incremental Output Ratio) a value of 2,47 was retrieved for Pakistan as an average. For the choice of delta, reasonable values range from delta = 0.04 to 0.08 (OZYURT, 2007). The value of 0,6 was used in this analysis, in line with the majority of proposals (FELIPE, 1997).

Equation 4: The Perpetual Inventory Method to Capital Stock Estimation

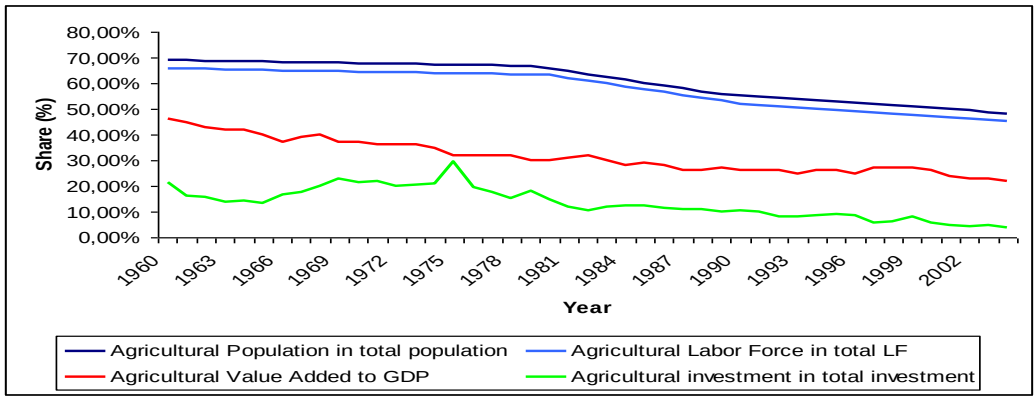
$$K_t = (1 - delta) * K_{(t-1)} + I_t$$

with Kt as the capital stock in time t, Delta as the depreciation rate and It as Investment in time t.

IV. Agricultural Productivity in Pakistan- Results and Discussion

The most comprehensive measure of aggregate or sectoral productivity is Total Factor Productivity (TFP). However, given the scarcity of good data, this area of research has remained quite limited in Pakistan (ALI, 2004). By using different indicators Figure 1 describes the importance of the agricultural sector in Pakistan.

Figure 1: The importance of Agriculture- measured by key indicators 1960-2004



Source: Own illustration, 2008

As illustrated by Figure 1, in the past 20 years the agricultural labor force has constantly lost its share in total labor force. Investments in this sector have been relatively on high levels during the phase of the green revolution (1966-1976), thereafter a decrease is indicated from formerly 30% in 1976 to less than 10% in 2004, this in relative terms. The share of agriculture in GDP has been decreasing since 1960, following the same pattern like investments and vice versa, one reason is that GDP growth in Pakistan from 1960-2004 has outperformed the growth rate of the agricultural sector, leaving the decrease to be a mere issue of ratios; not to forget that the growth of Output has been mainly carried by agriculture, at least up to the end of the 1990's. The question of interest therefore is, whether the agricultural Output has been growing or decreasing over this period and if efficiency levels have been the main determinants of growth, Figures 2 and 3 in particular are devoted to assess these questions of interest.

Figure 2: Inputs and Output in Agricultural Sector of Pakistan 1960-2004

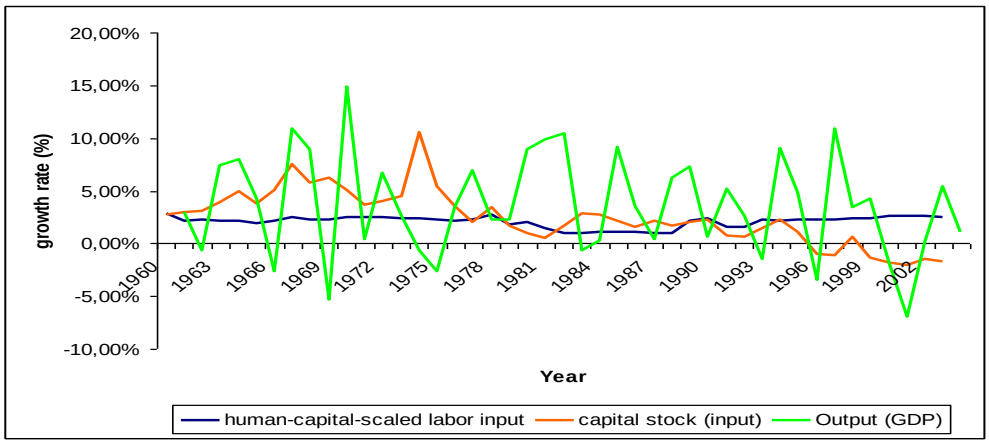
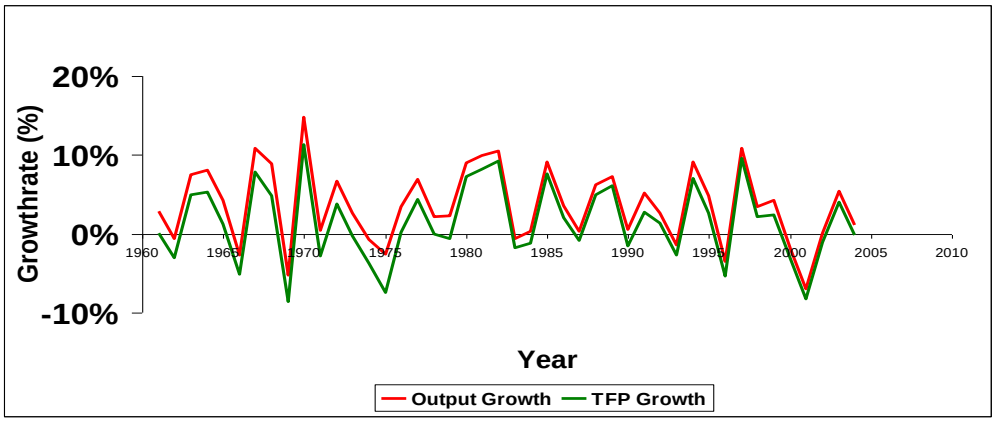


Figure 3: TFP- and GDP growth in Pakistan's Agriculture from 1960-2004



Sources: Own illustrations, 2008

The TFP calculations in this paper revealed an average annual Output growth of 3,9% in the Agricultural Sector. Despite technological progress (e.g. new varieties) the productivity gains have not been sustained in Pakistan, this is indicated by sharp fluctuations for the entire period. Alarmingly, despite rising per capita income, food demand is likely to grow rapidly given the low level of *current* per capita income. Recent projections for future food supply and demand, call for sustained efforts for increasing production of essential items (wheat, edible oils, etc.) (CHAUDHRY AND CHAUDHRY, 1997). Faced with limits to further expansion of cultivated land and slowing returns to further input intensification, productivity growth assumes a central role in meeting the challenges of the future, especially with climate change in discussion. The periods of high/low agricultural growth have generally coincided with periods of robust/poor performance of the national economy. Over the entire period Pakistan's agricultural TFP has grown with an annual average of 1,8%, very similar values were computed by other studies for a shorter time period (EVENSON et. al, 2004). The calculations "naively" interpreted, found a share of 44,8% in growth that is explained by TFP, whereas the "KR" (Klenow and Rodriguez-Clare, 1997) assessment produces a share of 97% (that if TFP grows this also is taken as a reason

to invest into the input side, resulting in higher returns.). A share of 44,8% means that there are other factors involved that determine growth, this is dealt with in the next chapter.

Table 1: TFP Estimation with the growth accounting approach-empirical results for selected periods for the Agricultural Sector

Period	GDP growth (%)	Minus share of Capital (%)	Minus share of Labor (%)	TFP growth (%)
1960-1965	4,38%	0,80%	1,87%	1,71%
1965-1970	5,13%	0,96%	2,25%	1,92%
1970-1975	3,53%	1,02%	2,38%	0,13%
1975-1980	3,52%	0,87%	2,04%	0,61%
1980-1985	6,35%	0,44%	1,03%	4,88%
1985-1990	4,52%	0,44%	1,02%	3,06%
1990-1995	3,47%	0,56%	1,32%	1,59%
1995-2000	3,01%	0,49%	1,14%	1,38%
2000-2004	-0,46%	0,38%	0,89%	-1,73%

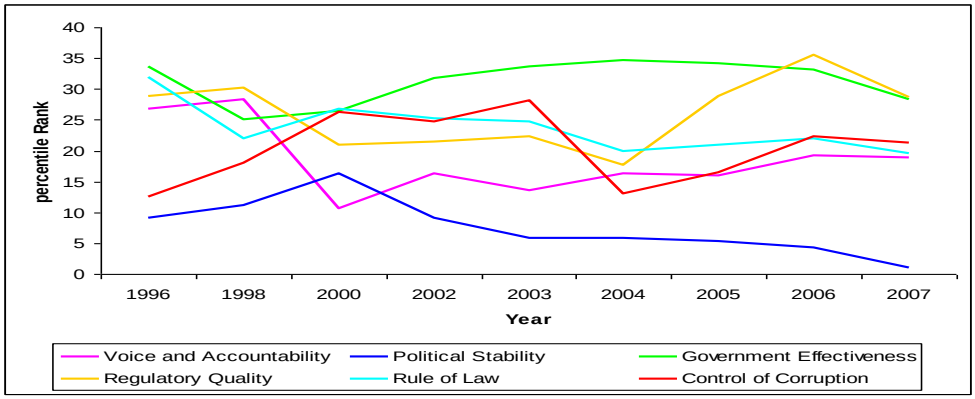
Source: Own illustration, 2008

Table 1 quantifies the above mentioned importance of the Labor input variable (human-capital-scaled labor) and of TFP, although they in future might be decreasing as the last period indicates.

V. Interpreting the country's failure- The Social Infrastructure

The institutions and government policies that determine the economic environment within which individuals accumulate skills, and firms accumulate capital and produce Output in this context can be aggregately referred to as "social infrastructure" (HALL AND JONES, 1999). The term social infrastructure in this paper includes the following variables: Voice and Accountability, Political Stability, Government Effectiveness, Regulatory Quality, Rule of Law and Control of Corruption (KAUFMANN et. al 2008). The following Figure shows Pakistan's state of "social infrastructure" or governance as a matter of fact.

Figure 4: Key governance indicators for Pakistan from 1996-2007

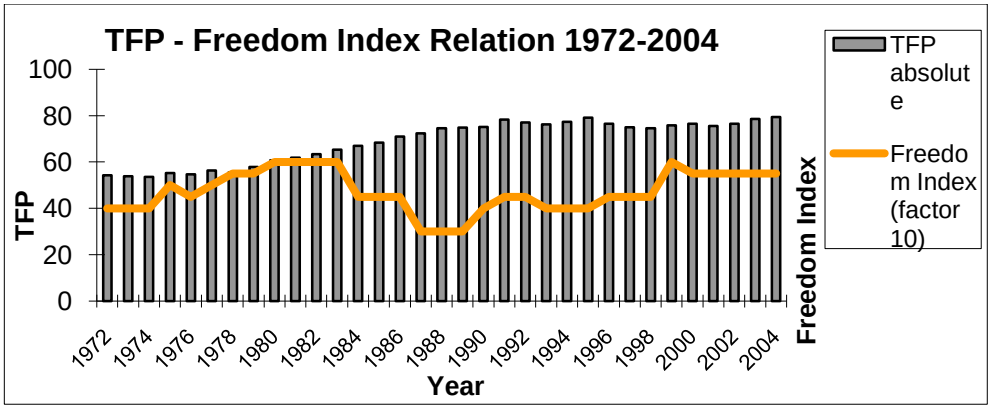


Source: own illustration after Kaufmann et. al, (2008)

Figure 4 illustrates the bad state of the social infrastructure in Pakistan, throughout the last 10 years, it has been worsening. Countries like Pakistan with corrupt government officials, impediments to trade, poor contract enforcement, and government interference in production, will

be unable to achieve levels of Output per worker anywhere near the norms of western Europe, northern America, and eastern Asia (HALL AND JONES, 1999). Thus, if Pakistan wants to improve its situation, it seriously has do tackle the causes for the weak social infrastructure and on a long term basis, sustain any achievements made in this field. Policy distortions, corruption, misgovernance, market failures, and externalities can lead to lower total factor productivity and underinvestments in important sectors such as education, research and development etc., which is the case in Pakistan. In this way the social infrastructure, the interdependency of the factors (H,K,R,Y) play a significant role for the outcome of a production process or the whole economy.

Figure 5: Productivity and the Social Infrastructure



Source: Own illustration, 2010

The following tables intend to briefly show the main results of this paper, the choice of the parameters is important, these hold true for both the CES and the CD function.

Table 2: Sensitivity of Estimates with respect to economies of scale 1960-2004

Average annual Growth Rates 1960-2004			
	Gamma <1	Gamma=1	Gamma>1
Output(Y)	3,90%	3,90%	3,90%
Capital (K)	2,70%	2,70%	2,70%
Labor(H)	1,90%	1,90%	1,90%
TFP	2,20%	1,80%	1,30%
Share of Growth due to TFP Growth			
	Gamma <1	Gamma=1	Gamma>1
Naive	55,90%	44,80%	33,80%
KR	97,30%	97,20%	97,10%

Source: Own illustration, 2010

Small differences in assumptions can lead to big differences in estimates of TFP growth, cautious approaches are needed, that are based on sound data.

VI. Conclusion and Outlook

The major finding of this paper is that despite relatively high aggregate productivity levels in the early period of the study (60's - 80's), the country has not managed to sustain its growth in the long run. Key factors that among other things have contributed to a slowdown in the growth of TFP during the 90's are the effect of vintages of capital characterized by under-utilization, fall in real public development expenditure and stagnation of manufactured exports, rapid population growth. The failure to enhance on human capital in Pakistan especially with regard to' research and development has handicapped progress and growth. For years the country has set its hopes on the uncompetitive textile sector. Whenever Pakistan in the last 44 years achieved high growth, either it was the green revolution responsible for it or mainly foreign capital inflow. The government failed to utilize the momentum of the early 1960s and thus through mismanagement, which is also incorporated in TFP, could not sustain the high growth rate of that period particularly. Little has been done in the sector of reforms to get rid of sicknesses like corruption for instance. Additionally to the issues common to all developing countries, Pakistan increasingly in terms of the social infrastructure as pointed out, has worsened significantly, i.e. receiving only one credibility point out of hundred in terms of political stability. Although income per capita in Pakistan over the period of study from 1960- 2004 has risen annually by 4,5%, this increase remains a nominal one, as the administration has not managed to keep inflation down, the basket of basic goods is getting more and more expensive. TFP in Pakistan will be a fundamental instrument to assess the areas where the reforms should grasp, for that further research will be needed, that will decompose the TFP variable into the individual contributors. The answer to the introductory question why basic goods are not available to most of the poor, is simply the failure to sustain achievements carried by TFP. The basic social infrastructure is weak, it does not distribute the achievements and gains from growth; grasping on the issue of the social infrastructure and tackling weak-points will therefore be a key to success, a failure will most probably make the poor even poorer. A great challenge for the future is going to be to feed the poor, hence the importance of agriculture from this point of view will have to remain, making it more productive accompanied by a strong collective infrastructure could be one possible solution.

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