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Macro Determinants of Total Factor Productivity in Pakistan

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By utilizing the conventional growth accounting framework, this study first estimates the Total Factor Productivity (TFP) in Pakistan and then establishes its macro determinants. Covering the sample from 1960 to 2003, the results confirm that macroeconomic stability, foreign direct investment, and financial sector development play an important role in the increase of TFP. Interestingly, education expenditures turn out to be insignificant.

JEL Codes: C13, O47
Key Words: Growth Accounting, Total Factor Productivity, Macro Determinants, Pakistan

1. Introduction

The economy of Pakistan has grown at an average annual rate of 5 percent with wide fluctuations across the five decades since independence and across each of the years within each decade. An average growth rate of 5 percent with an average annual ratio of 17 to 18 percent of investment to GDP indicates relatively low incremental capital-output ratio in Pakistan as compared to other developing economies. Importance of productivity study is, therefore, quite apparent. However, there have been relatively few estimates[1] of productivity growth in Pakistan and even fewer attempts[2] to explore the determinants of productivity at the macroeconomic level. This study adds to the existing estimates for Pakistan by first estimating TFP through conventional growth accounting process, and then establishing the macro determinants of TFP, by using a larger time series data than used by other studies.

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[1] Burney (1986), Kemal and Islam (1992), Kemal & Qadir (2002), Wizarat (1981 and 1989), and Pasha et al. (2002).

[2] Pasha et.al. (2002) and Sabir and Ahmed (2003).

Different factors have some role to play in determining how much output a country can produce. For example, factors of production such as the size of the labor force and the capital stock certainly matter; but a large number of other things such as education, government regulation, and even the weather have their roles to play. Any theory of economic growth has to make a choice on which of these factors to emphasize as a main source of economic progress or as an explanation for income differences across countries. Instead of comparing and evaluating different theories, it would be useful to have direct evidence on those factors that are important for growth. This is only possible through growth accounting framework[3] as it helps to segregate TFP from other sources of economic growth.

This study attempts to establish the macro determinants of total factor productivity (TFP) in Pakistan. The determinants are identified on the basis of a simple regression approach. The results of the estimates are significant, establishing the impact of a number of factors with TFP. In particular, these determinants are inflation, foreign direct investment, financial sector depth, private credit, budget deficit, population growth, investment, employment, and government consumption. Interestingly, the variables of education expenditures and openness of trade turn out to have negative association, while government consumption and foreign investment are positively associated with Pakistan's TFP.

This paper is organized as follows. Section 2 outlines the conventional growth accounting framework. Section 3 specifically focuses on Pakistan. It first notes the methods of calculating the fundamental sources of growth; namely, labor, capital, and productivity and then highlights TFP as the most important source of growth. Section 4 outlines the estimation model and justifies the choice of the determinants of TFP. Findings of the estimates are analyzed in Section 5. Final remarks on the caveats of TFP conclude the study in Section 6.

[3]In growth accounting, production function is used as an organizing device or accounting format (and not as an estimation framework) to isolate the contribution of various factors to output growth. The usual procedure is to assume linear homogenous production functions with relative input prices taken as reasonable measures of marginal products [Griliches and Jorgenson (1967), Christensen and Jorgenson (1970), and Denison (1979) remain the seminal works of this approach]. In fact, growth accounting literature is rich with several quantitative studies and technical dialogues [see, for example, Barro (1991), Collins and Bosworth (1997), Grier and Tullock (1989), Kormendi and Meguire (1985), Nadiri (1970), Levine and Renelt (1992), Lucas (1988), Mankiw et al. (1992), Rebelo (1991), Romer (1986)].

2. Aggregate Growth Accounting Framework and TFP

Growth accounting provides a breakdown of observed economic growth into components associated with changes in factor inputs and a residual that reflects technological progress and other elements. Generally, the accounting exercise is viewed as a preliminary step for the analysis of fundamental determinants of economic growth. The growth-accounting exercise can be particularly useful if the fundamental determinants that affect factor growth rates are substantially independent from those that affect technological change, such as government policies, household preferences, natural resources, initial levels of physical and human capital, financial sector development and so on. The basics of growth accounting are presented in Solow (1956 and1957), and Griliches and Jorgenson (1967).

Empirical growth accounting exercise uses the aggregate neoclassical production function to decompose the growth rate of aggregate output into contributions of growth of measured inputs and improvements in TFP. The results of this exercise depend critically on the specification of the production function. In literature, the Cobb-Douglas production function with the share of capital set to a 'bench mark' value of one third for all countries has typically been used [see, Young (1995) and Krugman (1994)], with the extensions by Collins and Bosworth (1997) and Sarel and Robinson (1997). However, we start with two inputs - capital and labor - and compute their specific shares through the simple Ordinary Least Square (OLS) method. We can specify an aggregate production function as follows:

$$Y_t = A_t f(K_t, L_t) \tag{1}$$

where, $'Y'$, $'K'$ and $'L'$ are output (GDP), capital and labor respectively, and $'A'$ is the level of productive efficiency, the so called TFP. We differentiate the above production function with respect to time, and obtain the growth rate of output decomposed into sources of growth: improvement in productive efficiency $(\dot{A}/A)$ and increase in factor inputs $(\dot{K}/K)$ and $(\dot{L}/L)$. Differentiating Equation (1) with respect to time and simplifying:

$$\frac{\dot{Y}}{Y} = \frac{\dot{A}}{A} + \frac{Af_k K}{Y}\frac{\dot{K}}{K} + \frac{Af_l L}{Y}\frac{\dot{L}}{L} \tag{2}$$

Af_k and Af_l are the marginal products of capital and labor, respectively, which are equal to the rental and wage rates if markets are competitive and firms

maximize their profits. Then, $Af_k K/Y$ and $Af_l L/Y$ are the shares of compensation to capital (α_k) and labor (α_l) in total output respectively. Since the share of capital income is one minus the share of labor income under the assumption of constant returns to scale, the growth rate of output is decomposed into TFP growth and the weighted sum of the growth of capital and labor is as follows:

$$\frac{\dot{Y}}{Y} = \frac{\dot{A}}{A} + (1-\alpha_l)\frac{\dot{K}}{K} + \alpha_l \frac{\dot{L}}{L} \tag{3}$$

Having data on the growth rates of output and inputs along with factor income shares, we can measure TFP growth from the above equation as residual output growth, after subtracting the contribution of measured input growth from output growth. Therefore, the above expression can be presented in the following equation:

$$\frac{\dot{A}}{A} = \frac{\dot{Y}}{Y} - (1-\alpha_l)\frac{\dot{K}}{K} - \alpha_l \frac{\dot{L}}{L} \tag{4}$$

According to the neo-classical growth model, which is supported by empirical evidence, factor accumulation exhibits diminishing returns. Thus, for sustainable long-run growth, a country cannot rely solely on accumulation of factor inputs, but must strive to sustain growth in TFP.

3. Construction of Variables and Data Sources

3.1. Measures of Output (GDP)

Different measures of output (GDP) have been used in the literature; some of these measures are mentioned in Table 1.[4] Output per capita increased on average from Rs 2064.9 in the 1960s to Rs 4330.9 in the 1990s, showing a twofold increase in four decades.[5] Similarly, it has shown increasing trend in the subsequent years of 2001-03. However, per capita output growth depicted a mixed trend from 1960 to 2003. Per capita output varied from minimum growth of -2.0 percent in 1971 to

[4] We did not use these indicators of output in the *Growth Accounting* exercise but we tried to present the historical development of these indicators in the mentioned Table 1.

[5] Output per capita is constructed on 1980-81 prices.

Table 1. Real Output Growth in Selected Periods

	1961-70	1971-80	1981-90	1991-00	2001	2002	2003
Output per capita	2,064.92	2,597.93	3,403.15	4,330.94	4,658.98	4,724.67	4,839.64
Output per employee	6,719.30	8,606.28	11,616.07	15,526.50	16,357.39	16,601.18	17,018.66
Output per capital (% changes)	3.63	1.47	2.97	1.94	0.23	1.41	2.43
Output per employee (% changes)	3.45	1.31	3.84	1.79	1.72	1.50	2.51

maximum growth of 6.4 percent in 1965. Output per capita growth dipped suddenly to 1.47 percent in 1970s relative to higher growth of 3.6 percent during the preceding decade of 1960s. However, it rose again to 3 percent in the decade of 1980s followed by the slowdown of 1.9 percent of per capita growth during 1990s. Since 2001, it has shown an upward trend, and climbed to 2.43 percent in 2003 that is almost equal to the average growth of per capita output during the last forty years. Thus, output per capita growth followed cyclical behavior with sluggish growth in GDP and high growth in population.

We use real GDP, as an output growth indicator in the growth accounting model, specified in Equation (3). The growth rates of real GDP are computed in percentages. Data series covers the period 1960-2003 and is taken from Federal Bureau of Statistics (1998) and Government of Pakistan: Economic Survey (2004).

3.2. Measures of Labor (Input)

Labor, used as an input in the above mentioned production function, is measured in a number of ways depending on data availability. For example, labor input is measured as the number of hours worked. However, the time series data on working hours is not available in Pakistan. In addition, due to the emerging importance of human capital that may affect worker quality, labor input is adjusted by a quality change generally measured by the increase in schooling years. Here, again we face the same problem of data non-availability. Nonetheless, we have measured labor input as the number of workers in the economy as reported in the various issues of "Economic Survey". Labor force is measured in millions and the series ranges from 1960 to 2003.

3.3. Measures of Capital (Input)

To estimate the capital stock we use the perpetual inventory method, which takes the stock of capital as the accumulation of the stream of past investments:

$$K_t = I_t + (1-\phi)K_{t-1} \tag{5}$$

Using the concept of initial capital stock $K(0)$, we follow Nehru and Dhareshwar (1993) in the construction of the capital stock series:

$$K_t = (1-\phi)^t K(0) + \sum_{i=0}^{t-1} I_{t-i}(1-\phi)^i \tag{6}$$

where, ϕ is the rate of geometric decay and $K(0)$ is the initial stock in period zero. Initial capital stock can be estimated in a number of ways. Nehru and Dhareshwar (1993) use a modified Harberger (1978) method to compute $K(0)$. The value of investment in the first period is estimated through a linear regression of the log of investment against time. The fitted value of initial investment is used to calculate initial capital stock using the following equation:

$$K_{t-1} = \frac{I_t}{(g+\phi)} \tag{7}$$

In Equation (7), g is the rate of growth of output (GDP) and ϕ is depreciation rate of capital. The other important estimate needed is depreciation rate. Many studies [such as Nehru and Dhareshwar (1993) and Collins and Bosworth (1997)] have chosen 4 percent per year rate of depreciation and we also use the same arbitration.

We also compute capital intensity with respect to labor. It shows output produced by the labor input relative to capital. It gives us information about the exchange of inputs, capital and labor in output. The increase in capital intensity suggests decrease in the productivity of labor.

We estimate capital intensity on the lines of Abramovitz (1993):

$$\frac{(1-\alpha)\left(K/L\right)}{Y/L} \tag{8}$$

where, $(1-\alpha)$, K, Y, and L are respectively the weight of capital, capital, GDP, and labor force in the growth accounting model.

Table 2. Capital Formation and Labor Force Growth in Selected Periods

	1961-70	1971-80	1981-90	1991-00	2001	2002	2003
Real capital stock growth	4.78	4.28	4.96	4.47	3.06	2.92	2.54
Investment output ratio	26.02	22.44	21.79	19.47	16.50	15.50	15.00
Capital output ratio	296.79	273.26	241.43	235.32	237.60	236.10	231.50
Employment growth	3.14	3.31	2.21	2.65	2.13	2.09	2.02
Population growth	2.86	3.14	3.04	2.45	2.22	2.17	2.10
Capital intensity*	1.90	1.75	1.55	1.51	1.52	1.51	1.48

* calculated on the lines of Abramovitz (1993)

With reference to measurement of capital stock, some conventional measures are also presented in Table 2. First, GDP (Output) growth rate and capital stock (input) growth rate trend follow each other on average over a period of the last 43 years. Second, Investment output ratio is computed as a percentage of GDP (Table 2). This ratio showed declining trend throughout the period of analysis. It does not follow the cyclical trend as output per capita shown previously in Table 1. Third, we find a similar image in the development of declining capital output ratio.

3.4. Total Factor Productivity (TFP)

Despite the importance of the contribution of factor accumulation to output and real income expansion, the critical effect of TFP on growth has been widely accepted for quite some time.[6] Total factor productivity is measured[7] from Equation (4) which is extracted from the growth accounting Equation (3). TFP reflects output per unit of a set of combined inputs. With reference to Equation (4), a change in TFP reflects the change in output that cannot be accounted for by the change in combined inputs. TFP as a result reflects the joint effects of many factors (macro and micro level) including research and development (R&D), new technologies, economies of scale, managerial skills, and changes in the organization of production.

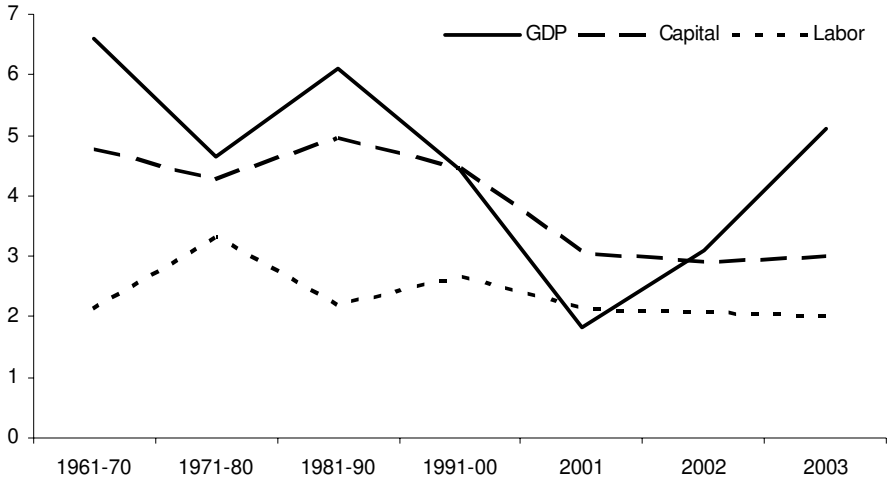
3.5. Analysis

3.5.1. Growth in Inputs and the Output

Relative changes in growth of inputs and output are illustrated in Figure 1 that depicts the pattern of output growth with different combinations of factor inputs

[6] Solow (1956) and (1957), Dowling and Summers (1998), and Easterly and Levine (2000).
[7] There are other methods of measuring TFP; see for example, Fare, R. et al (1994) and Young (1995).

Figure 1. GDP Growth and Inputs Growth



growth. GDP growth does not follow the stable pattern, rather the cyclical pattern. Similarly, input growth is volatile in nature. GDP showed 6.6 percent annual average growth in the 1960s with 5 percent average annual growth in capital and 2 percent in labor input. However, during the 1970s, GDP growth rate decreased sharply to 4.6 percent with the combination of 3.3 percent growth in labor and 4.2 percent growth in capital input.

Here, we find that GDP growth is more sensitive to capital input growth relative to labor input growth. It implies that mere increase in labor input did not add to GDP growth; however, slowdown in the growth of capital input pulled down the growth in output during the decade of 1970s. In the subsequent decade of the 1980s, there is recovery in GDP, showing 6.1 percent annual average growth that is comparable with GDP growth during the previous decade of the 1960s. The improved GDP growth of 6.1 percent during the 1980s is depicted with the growth of 4.8 percent in capital and 2 percent in labor input. Interestingly, GDP growth appeared with almost the same growth of the 1960s but capital input growth was relatively less as compared with that of the 1960s. It implies that increased output growth is due to something else instead of mere accumulation in the growth of inputs (labor and capital). Thus, increased output growth may be due to increased productivity of factor inputs.

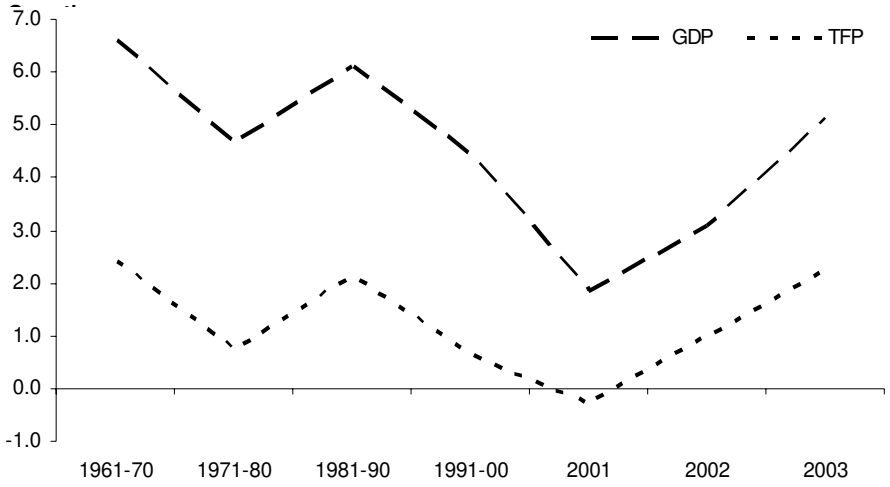
In 1990s, the scenario is different regarding output growth and the growth in factor inputs. The 1990s recorded 4.4 percent growth which is almost equal to the growth of capital input and labor growth remained approximately constant during the mentioned period. Interestingly, growth in labor and capital was not drastically low that could depress the growth of GDP consequently. The argument is that mere factor inputs could not always help to increase growth of output. It seems that TFP growth could play an important role in driving output growth upwards, besides the growth of factor inputs only.

We conclude from the above discussion that labor and capital are complimentary to GDP growth but do not exactly account for economic growth. We have also seen that capital appeared as one of the major inputs, but not the only leading factor in driving economic growth.

3.5.2. Output and TFP Growth

Figure 2 presents the graphical explanation of both GDP and TFP growth. It is observed that the growth of GDP and TFP followed identical behavior throughout the period of observation. It reflects that, if growth of TFP rises, GDP growth also takes momentum and vice versa. Specially, during the 1960s, 2.4 percent growth of TFP followed by the relatively 6.6 percent higher growth of GDP was observed as the highest ever during the subsequent period of analysis. During the 1970s TFP growth dipped to 0.73 percent and it pulled GDP growth down to 4.6 percent,

Figure 2: GDP Growth and TFP



obviously much lower than the 6.6 percent growth of GDP in the preceding decade.

However, in the next decade of the 1980s, 2.1 percent growth of TFP improved significantly over the preceding decade. Similarly, GDP growth took momentum and increased by 6.1 percent during the period of the 1980s. Contrary to the 1980s, diminished growth of 0.6 percent of TFP resulted into 4.3 percent relatively lower growth of GDP during the 1990s. It is concluded from the above discussion that TFP growth and GDP growth patterns are examples of high degree of correlation, which is 88 percent.

4. Determinants of Total Factor Productivity

Continuing with the above discussion, it is now proper to identify the determinants of total factor productivity that played an important role as one of the leading indicators in driving the direction of GDP growth in the growth accounting process. There is a large and growing body of empirical literature that seeks to explain the process of GDP growth in individual and cross-country settings but little evidence is available with respect to TFP [Senhadji (1999)].

In this section an attempt is made to investigate the macroeconomic determinants of TFP in Pakistan's economy. There is a considerable amount of empirical literature that seeks to explain the process of growth in individual and cross-country settings but very few studies explore the causes of variation in TFP. Some studies have partially incorporated the discussion on determinants of TFP.[8] The study by Pasha et al. (2002) presents the results of the OLS regressions of the determinants of TFP, for individual sectors and for the economy of Pakistan, as a whole. Another study by Sabir and Ahmed (2003) slightly differs from Pasha et al. (2002) but arrives at the same conclusion that human capital, cotton yield, vintage capital, development expenditures and remittances are the important factors of determining TFP in the economy of Pakistan.

The Model

The basic empirical framework employed in this study is based on the determinants of economic growth and, more specifically, the macro determinants of TFP. We specify a simple model of TFP:

$$TFP_t = \alpha + X_{it}\beta + \mu_t \qquad (9)$$

[8] See, for example, Griliches (1994), Lipsey (1996), and Basudeb and Bari (2000).

where '*TFP*' refers to total factor productivity, 'X_i' represents the vector of determinants of TFP and μ is an error term.

The determinants (X_i) of TFP are broadly categorized into macroeconomic stability, openness of economy, human resource development and financial sector development and a set of control variables. Therefore, Equation (9) can be written as follows:

$$\begin{aligned} TFP_t = {} & \pi_0 + (Macroeconomic\ Stability)t\pi_1 + (Openess\ of\ Economy)t\pi_2 \\ & + (Human\ Sector\ Development)t\pi_3 + (Financial\ Sector\ Development)t\pi_4 \\ & + (Control\ Variables)t\pi_5 + \mu_t \end{aligned} \tag{10}$$

where, π_1, π_2, π_3, π_4 and π_5 are parameters of the determinants of TFP and control variables respectively. Specifically, macroeconomic stability can be assessed through low and stable rate of inflation. Openness of economy can be measured by the ratio of sum of imports and exports to GDP, and the degree of inflow of foreign direct investment. Human sector development can be gauged through education expenditures indicator. Finally, financial sector development is proxied by the indicators of size of private credit expansions and monetary aggregates (M2) to GDP ratios. Besides these specific determinants of TFP, some control variables are also incorporated in the model. Broadly, control variables include budget deficit, government consumption, population, investment and labor indicators.

Inflation: Role of inflation in growth is controversial among the theorists and policy makers on several occasions. The controversy is beyond the scope of this study. We have used inflation as a regressor in the model to capture the stability of economy, which is hypothesized as necessary for TFP growth. Furthermore, developing economies signal the impact of money illusion, which is why inflation is necessary to be included as a macroeconomic determinant of TFP. It is also true that inflation adds to economic growth by generating employment or merely increasing the working hours of employed labor in a sense that the positive relationship of inflation and TFP can be expected.

Openness of Trade: We use the sum of imports and exports to GDP ratio to measure the openness of trade. Openness is generally believed to have a favorable impact on economic growth through increasing productivity of the economy. It is believed that more open economies can grow more rapidly through greater access

to cheap imported intermediate goods, larger markets, and advanced technologies that contribute to TFP.[9]

Foreign Direct Investment: Foreign direct investment also plays an important role in driving growth through increase in productivity levels. Foreign direct investment brings technology and creates employment. It helps to adopt new methods of production and enhances productivity by bringing competition in the economy. Foreign direct investment also introduces to novice management and organizational skills, and explores hidden markets in the economy. It reduces the barriers in adoption of technology and brings improvements in the quality of labor and capital inputs in the host economy.

Education Expenditure: The indicator of education expenditure is somewhat a broader measure of human capital. Government intervention in the market for training and higher education would likely improve the allocation of resources and thereby raise productivity growth over the long term. Investment in education promotes more skilled and specialized labor input. Since more skilled workers are better able to adjust in a dynamic, knowledge-based economy, this will result in enhanced productivity performance. Sharpe (1998) has argued that with stable macroeconomic environment, increased public support for training, higher education, research and development enhances overall productivity of the economy.

Private Credit/Financial Sector Depth: In general, financial sector may influence TFP through two channels, which are known as quantity channel and quality channel. The quantity channel effect basically describes how the financial sector can affect the rate of capital accumulation. Capital accumulation is more rapid when the financial sector can induce people to save more or assist in bringing superior technologies. The quality channel effect stresses the importance of financial services that can affect the rate of technological innovations.

The quality channel effect stresses the importance of financial services that can affect the rate of technological innovations. Technological innovations and improvements become faster as the financial sector helps revealing the potential rewards to engaging in innovations, relative to continue making existing products with existing techniques.

Private credit, specifically finds new areas of investment under the efficient allocation of resources. Easy access to credit not only enhances economic growth

[9] Lewis (1980), and Grossman and Helpman (1994).

but also the productivity of firm level and contributes to TFP of the overall economy. Broadly speaking, it is the development of financial sector that facilitates the credit, necessary for healthy business and reflects positive relationship with TFP. In order to see the effect of financial sector development on TFP we also use M2 to GDP ratio as another measure of financial sector depth.

Budget Deficit: Budget deficit indicates the size of an economy. The expansion in the economy is related to the general government expenditure for the purpose of development. Moreover, budget deficit gives the composite picture of revenues (taxes) and expenditures (developmental and non-developmental). Thus, budget deficit can affect the efficiency and productivity of an economy.

Investment and Employment: Productivity refers to the efficiency with which an economy transforms inputs into useful outputs. In growth accounting, investment and employment are the basic inputs of economic growth. Therefore, the combination of these inputs determines the level of productivity in the economy. We estimate the model by holding the effect of investment and employment all together, in order to avoid biased estimation. A more productive economy requires fewer inputs to produce a given quantity of output.

Government Consumption: We use government consumption as a share of GDP to observe its effect on TFP. Studies on economic growth have increasingly focused on the role of government in the process of economic growth. Ranis (1989) argues that government can both foster and hinder the process of economic growth depending upon the nature of its activities. In particular, provision of basic public goods would enhance the productivity of labor and overall productivity by diverting resources from non-productive uses.

Population: Population growth may affect the pace of economic development at some point in time positive or negative direction. Although we cannot establish the strong and direct relationship between population growth and TFP, we try to observe the empirical relationship between these two variables in this model. We expect that population growth may affect TFP negatively, since the idle labor accumulation is also one of the causes of lower TFP.

5. Empirical Results

Empirical results[10] are presented in the form of three estimated regressions (Table 3). First two regressions (Regression I & II) are considered independent in nature

[10] Data ranges from 1960 to 2003. The simple OLS technique is applied to estimate the regression

rather than alternatives in the choice of variables to some extent.[11] The basic purpose of presentation of the results in this way is to encompass the wider range determinants of TFP without losing degrees of freedom in the estimation of regression. Regression III is the summation of earlier two regressions.

Table 3 summarizes all the regression specifications. In Regression I, inflation is positive and statistically significant in the estimated model (Equation 10) but with small coefficient; it implies that one percentage point change in inflation increases TFP by 0.04 percentage points. This quantification has specific meanings regarding role of inflation with TFP; that is, statistically significant inflation with lower coefficient depicts its facilitating role in determining TFP. Low and stable inflation specifically provides favorable environment in the growth of TFP. The coefficient of budget deficit in Regression I appear significant with negative sign, implying that it may hamper growth in TFP.

As hypothesized above, increase in education expenditures shape up the human capital of the country and leads to enhance productivity of labor input. Results of this study interestingly do not conform to the aforementioned hypothesis. It can be attributed to many reasons. Nonetheless, it may reflect the lack of skill oriented education (the accepted phenomenon to raise TFP) in Pakistan's education system. The possibility of suboptimal allocation of resources can not be ruled out either.[12]

Another interesting result is the negative association of openness of trade with TFP. Perhaps, the negative coefficient reflects the deficiency of economy in adopting or imitating the technology that trickles through trade. There could also be the reason of maximum dependence of domestic economy on foreign manufactured goods. The results of financial sector development conform to the theory. Financial depth measured as M2 to GDP ratio enters with a positive sign and significant statistically in the estimated model.

As shown in Table 3, Regression II improved over Regression I. The coefficient of inflation is not much different to that of Regression I. Similarly, the coefficient of private sector credit (an indicator of financial sector development) is robust with

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equations. Further, variables are transformed (where necessary) to bring them on the same order of integration, I (1), in order to avoid the problem of spurious regression.

[11] Computation and the endogeniety of TFP have remained contentious among authors [for a critical survey, see Felipe (1997)]. The specification here might also appear to be arbitrary; however, recall that TFP is the residual of production function.

[12] Stories of 'ghost schools' are one manifestation of this phenomenon; see, a relevant article on education in Pakistan "Salvaging Education: A New Vision" by S.M. Rahman available at http://www.friends.org.pk.

Table 3. OLS Estimates of Total Factor Productivity Equations (Dependent Variable: TFP)

	Regression-I	Regression-II	Regression-III
Constant	-1.26	-0.64	-0.27
	(2.30)	(2.25)	(2.69)
	[-0.55]	[-0.28]	[-0.10]
Inflation	0.04*	0.05*	0.05*
	(0.02)	(0.02)	(0.02)
	[2.23]	[2.83]	[3.18]
Budget Deficit	-0.10***		-0.003
	(0.06)		(0.04)
	[-1.73]		[-0.07]
Education Expenditure	-0.27		-0.18
	(0.22)		(0.16)
	[-1.23]		[-1.13]
Openness of Trade	-5.21*		-0.98
	(0.95)		(16.34)
	[-5.46]		[-0.06]
Financial Depth	0.002*		0.001
	(0.00)		(0.00)
	[3.55]		[1.10]
Population	-0.19		-0.28**
	(0.17)		(0.15)
	[-1.14]		[-1.85]
Private Credit		4.51*	4.27**
		(1.94)	(2.29)
		[2.32]	[1.86]
Domestic Investment		0.12*	0.14**
		(0.06)	(0.07)
		[2.02]	[1.85]
Employment		0.34*	0.34*
		(0.03)	(0.08)
		[10.98]	[4.39]
Govt. Consumption		14.52*	13.50*
		(5.06)	(6.09)
		[2.87]	[2.22]
Foreign Direct Investment		0.79*	0.63
		(0.31)	(0.44)
		[2.50]	[1.41]
R-squared	0.94	0.97	0.98
Adjusted R-squared	0.93	0.96	0.96
S.E. of regression	0.72	0.45	0.43
Durbin-Watson stat	1.17	1.65	1.55

Figures in ( ) and [ ] show the values of standard error and T-stat respectively
*, ** and *** show the level of significance at 1%, 5% and 10% respectively

positive sign in the model. It implies that increasing private credit facilitates the quality of inputs that is considered an important role player in enhancing TFP. All of the other variables like domestic investment, FDI, employment and government consumption appear with the positive coefficient and are statistically significant.

Finally, the study attempts to observe the consistency in the behavior of all the specified determinants in the form of Regression III. It is important to note that all of the determinants incorporated in Regression I or Regression II do not change their signs in the encompassing regression III. However, note that the indicators of financial depth and openness of trade do not remain significant in the encompassing Regression III. It implies that the indicators of financial depth and openness of trade are sensitive to determining TFP. Furthermore, the inconsistent behavior seems to be a statistical one; that is smaller degrees of freedom are available in the Regression III. On the other side, all of the variables included in the Regression II are consistent in Regression III, except for foreign direct investment. Again it can possibly be attributed to low level of degrees of freedom available in Regression III. On the basis of this empirical exercise it can be concluded that Regression II is the best fit of the determinants of TFP in Pakistan.

6. Concluding Remarks

Errors of measurement can lead to substantial errors in the estimated residual (so called TFP), as emphasized by Griliches and Jorgenson (1967) and Christensen and Jorgenson (1970). While drawing conclusions from the Solow residual (TFP) one must keep the following things in mind. First, a significant fraction of economic activity is in the informal sector, which is not documented and accounted for. If this lack of documentation affects all factors equally it should not bias the TFP estimates, but if it does not, the sector that is neglected more will have its contribution underestimated.

Second, labor force series used above account for the total number of people in the labor force. No distinctions are made about the quality augmentation of the inputs (labor and capital). If labor force has become more skilled over the years it is not captured in the numbers and the contribution of labor is underestimated. More importantly, since such incorporation is likely to increase the attribution to labor, it will tend to depress the residual even further. However, conventional TFP measures the shift in the implied production function and is accurate under the assumption of TFP model. There are many potential problems with the maintained hypothesis of the TFP model, as Hulten (2000) observes, "The model's assumptions are not the first place to look. A much bigger problem lies in the interpretation of the results."

These caveats notwithstanding, this study has attempted to establish the determinants of TFP in Pakistan. The results of financial sector development conform to the theory. The positive result of financial sector development implies that financial sector may influence TFP through two channels, which are known as quantity channel and quality channel. Private credit, specifically finds new areas of investment under the efficient allocation of resources. Easy access to credit not only enhances economic growth but also the productivity of firm level and contributes to TFP of the overall economy. The highlight of the findings remains the negative impact of education expenditures. This indeed is a challenge to conventional wisdom and definitely calls for a detailed perusal of the relationship between education expenditure and TFP in Pakistan.

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