The Significance of Research and Development for Economic Growth: The Case of Pakistan

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Abstract

This paper concentrates on the significance of Research and Development (R&D) for economic growth in the developing economy of Pakistan. The paper also questioned the major macro determinants of R&D in Pakistan. The study used time series data for the period 1971-2008. The results obtained from the Ordinary Squares method showed that R&D significantly affects the Real GDP per capita in Pakistan. Health, labour force , and Physical capital are among the other determinants of Real GDP per capita. The results further show that real GDP per capita and quality of educational institutions are the significant factors which affect R&D. The Johansen Cointegration test confirmed the existence of long run relationship between R&D and economic growth. Similarly, R&D and its determinants were also found in long run relationship.It is therefore recommended to increase investment in R&D to achieve sustained economic growth. It is also recommended to collect and record quality R&D data for effective policy making in the field of science and technology, and social sectors in Pakistan.

Key Words: Research and Development, Economic Growth, Health, Labour Force, Quality of Educational Institutions

Introduction

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Pakistan is the 6th most populous country of the world comprising of 177.1 million people. Being a developing economy,it is struggling hard to achieve sustained economic growth. The economist and policy makers of Pakistan are working hard to unveil the determinants of economic growth in Pakistan. Azam and Khattak (2005) found Foreign Direct Investment, Domestic Investment and Trade openness as the significant determinants of economic growth in Pakistan. It has not been so far able to utilize its population optimally. Budget deficit and foreign debt are also considered as important determinanats of economic growth in Pakistan.

Iqbal and Ghulam (1998) declared primary education and physical capital as the pre-requisites for economic growth of Pakistan. Education is considered an important tool for economic growth and Pakistan will have to keep education on top priority in public policies in order to achieve sustained economic growth (Khattak and Jangraiz, 2012b). Similarly, health, Total Factor Productivity, and labour force are the long run drivers of Pakistan economy and increase in expenditure on higher education can produce far reaching results for economy (Khattak and Jangraiz, 2012a).

Research and Development (R&D) is emerging as another important tool for economic growth in modern era. Its role in economic growth was also emphasized in New Growth Theories. R&D results in innovation, which improves the quality and quantity of production. The research firms enjoy the monopoly benefits which they get after each innovation but these benefits are destroyed by next innovation (Aghion and Howitt, 1992).Engelbrecht (1997) suggested diverse role of human capital and R&D in domestic innovation and international spillover of knowledge. This spillover leads to economic growth. Blackburn (2000) integrated Research and development with human capital accumulation in an endogenous growth model and used the ideas of Lucas (1988), Uzawa (1965), Grossmann and Helpmann (1989), and Romer (1990).These studies recommend accumulation of skills and knowledge to achieve economic growth. Human capital accumulation not only accelerates economic growth but also provides incentives for research and innovations. It improves the quality of manufacturing.

Ballot *et al* (2001, Zeng (2001), Chou (2002), Jones (2002), Lee (2005), Kwack and Yang (2006) and many other[3] emphasized the role of R&D and education in economic growth. Besides utmost significance of R&D for economic growth, unfortunately, the R&D sector has not been successful to get proper attention of policy makers in Pakistan. This paper seeks the significance of R&D in the economy of Pakistan during the period 1971-2008.

R&D and Economic growth Profile of Pakistan

The economic growth performance of Pakistan remained impressive during last few decades. Agriculture, industry and services sectors have been and are still major contributors to Gross Domestic Product (GDP) growth. However, the contribution of agricultural sector is decreasing and the share of industry is increasing. The share of agriculture to GDP, which was 53.2 % in 1950, fell down to 30.6% in 1980 and 23.3% in 2005 (State Bank of Pakistan, 2005). Industry which provided 9.6% of GDP increased its share to 22.6%. Pakistan economy grew at the rate of 2 % during 2008-9 (Economic Survey of Pakistan, 2008-9). When Pakistan came into being, its growth rate remained 3.14 % in its first decade. The low growth performance was due to agricultural and industrial backwardness, low exports and developing trade relations. The growth performance remained sustained during 1961-1970 but again fell to 4.6% in 1970s.The biggest tragedy of Pakistan happened during this decade when Pakistan disintegrated into two independent states, Pakistan and Bangladesh. The period 1991-2000 was a comparatively relaxed period in Pakistan growth history and its economy grew at 6.15 % during this period. During this period Pakistan experienced democracy from 1991 to 1998 and military government in the remaining part of the decade. The economic growth rate remained 4.68% during the period 2001-2008. Pakistan annual growth performance has been shown in the following table with comparison of growth performance of neighboring countries (SBP, 2005; Economic Survey of Pakistan, 2008-09).

Research plays an important role in economic growth of a country through technological advancement and spillover effects. Research and Development expenditure can be more productive if made on high-tech sector than other sectors (Nadiri, 1993).

[3] For details see Grossman (2007), Afza and Nazir (2007),Falk (2007), Goel *et al* (2008) Kuo and Yang (2008) and Sterlacchini (2008)

In Pakistan, expenditure on R&D is mostly made by the government of Pakistan through investment in higher education. Universities are considered home for research and expenditure made on higher education does play an important role in R&D. There are also few specialized organizations working for R&D in Pakistan. The research expenditure and quality has improved in recent decades after the formation of Higher Education Commission (HEC) of Pakistan in 2001.Before formation of HEC in 1976, the number of publication in Pakistan was 271 per annum only (ISI, 2010).This number almost doubled in 1984-85 when the number of publications reached 512. The 2000s is a decade of research for Pakistan because the number of publication, number of research organizations and expenditures on research all increased with acceptable pace. The publications increased from 1305 in 2000-01 to 7661 in 2008-09.

The expenditures in Research and Development (R&D) by a country show its interest in science and technology and other sectors which lead to economic development. It has been observed that rich countries of the world with huge pool of resources spend huge amounts of money on R&D. During the year 1999-2000 the world expenditures on R&D increased from 410 billion USD to 755 billion USD and out of this 80% was made by OECD countries (UNESCO, 2004). Due to lack of availability of data on R&D, expenditures on higher education was taken as proxy for R&D because in Pakistan most research is conducted in higher education institution. Another justification for the use of this expenditure as expenditure on R&D is that high correlation has been noted in higher education expenditure and number of scientific publications.

As discussed above R&D sector is so far a neglected sector in Pakistan.It is spending a meager percentage of its GDP on R&D as shown in the Table I. Pakistan spent 0.16% of GDP on R&D in 1997. The expenditure on R&D fell in coming four years but a frictional increase 2001. The R&D expenditure showed a visible expansion in 2005 (0.44% of GDP). The government of Pakistan realizing the importance of R&D, increased the expenditure on R&D to 0.68% of GDP in 2007. The establishment of Higher Education Commission (HEC) of Pakistan in 2001 is believed to be the major cause of development of R&D sector in Pakistan

Table I Research and Development Expenditure as a percentage of GDP

Year	Pakistan	India	China	Italy	USA	Australia
1996		0.65	0.56	0.98	2.55	1.65
1997	0.16	0.69	.64	1.02	2.58	
1998	0.11	0.71	.65	1.04	2.60	1.51
1999	0.12	0.74	.75	1.02	2.64	
2000	0.13	0.77	.90	1.04	2.70	1.57
2001	0.17	0.75	0.95	1.08	2.72	
2002	0.21	0.74	1.07	1.12	2.62	1.74
2003	-	.72.0	1.13	1.10	2.62	
2004	-	0.74	1.22	1.09	2.54	1.84
2005	0.44	0.78	1.32	1.13	2.57	
2006	-	0.76	1.38	1.17	2.61	2.17
2007	0.68	0.76	1.39	1.23	2.67	
2008	-	-	1.46	1.27	2.78	2.35

Source: World Development Indicators (2010)

Data and Methodology

Data

This paper is based on secondary data for the period 1971-2008. The sources of data are State Bank of Pakistan, Economic Survey of Pakistan (Various Issues) and World Development Indicators.

Methodology

The empirical model for the present study has been derived from Khan (2012) as given below

$$Y = f(K, L, He, RD) \qquad (1)$$

where

Edu = Education, $He =$ Health, and RD = Research and Development

The model can written in empirical form as below

$$lnY = \alpha_0 + \alpha_1 lnK + \alpha_2 lnL + a_3 lnHealth + a_4 lnRD + U_i \qquad (2)$$

In equation (2), Y is the economic growth which has been measured by Real GDP per capita[4]. Physical capital is measured by Gross Fixed Capital Formation (GFCF) following the economic growth literature[5]. Health is another important variable of this paper. Life expectancy has been used as a measure for health in the present study[6]. Similarly, the labour denoted by L in equation (2) shows the total labour force in the economy.

Research and Development (R&D) is another important variable inducted in growth determinants in New Growth Theories. Much struggle has been made to get data for R&D. Unfortunately, not much data is available on R&D in Pakistan. Only a few years' publication data was available. As most of research is carried out in higher education institutions in Pakistan, so the expenditure on higher education was considered a proxy for it. This is also justified on the ground that high correlation was found between the Expenditure on higher education and publication per year from 1975-2008. This means that increase in higher education expenditure led to increase the research activities in Pakistan so this proxy is being used in the present study.

$$lnRD = \gamma_0 + \gamma_1 lnRGDPPC + \gamma_2 lnENR + \gamma_3 lnEdins + \gamma_4 lnPTR + U_i \qquad (3)$$

In equation (3), RGDPPC is the Real GDP per capita, ENR is educational enrollment, Edins means number of educational institutions and PTR which is the Pupil-Teacher Ratio, shows the quality of educational institutions.

We employed different econometric techniques Ordinary least square, Augmented Dickey Fuller Test and Johanson cointegration test for analysis.

Results and Discussion

The empirical section of this paper starts with the regression results. The study treated Real GDP per capita as the dependent variable against a set of explanatory variables. Health is considered as an important measure for human capital and as expected it appeared as positive

[4] See for details Asteriou and Agiomirgianakis (2001), Bloom et al (2000), Bhargava et al(2001), Barro (1991) and Borensztein (1998)

[5] Lin(2004), and Khan (2012)

[6] Barro and Lee (1994), Barro and Sala-I-Martin(1995), Barro (1996), Caselli *et al* (1996), Bloom and Malanaey (1998),Bloom *et al* (2000), Sachs and Warner(1997), McDonald and Jennifer (2002) and Ozcan et al(2000) used life expectancy as a measure for health.

and significant variable in this study. This means that increase in life expectancy leads to increase in real GDP per capita in Pakistan which is logical finding. The results show that Research and Development in Pakistan positively affect Real GDP per capita and the result is statistically significant. This points out the significant role of R&D in economic growth of Pakistan. Another important variable of the study was labour force. The study found labour force a positive and significant contributor to the Real GDP per capita in Pakistan. The physical capital also remained statistically significant variable but the sign is unexpectedly negative. The results are displayed in the Table II.

Table II OLS Results for Economic Growth Model

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LGFCF	-0.209405	0.070660	-2.963555	0.0056*
LHEALTH	2.328205	0.689845	3.374969	0.0019*
LTLF	0.874608	0.258776	3.379792	0.0019*
LRD	0.121344	0.034315	3.536162	0.0012*
C	-16.45992	3.302600	-4.983927	0.0000*
R-Sq 94.6%		F-statistic 146.3329		
R-Sq (Adj) 94.0%		Prob(F-statistic) 0.000000	LM Stat	1.88

The results from R&D model found Economic Growth, and quality of educational institutions as the significant determinants of R&D in Pakistan. The Real GDP per capita positively affects the process of Research and Development and the result is highly significant. The coefficient PTR is negative but statistically significant. This means that lower PTR which shows high quality of education accelerates the R&D process while higher PTR (Lower Quality of Education) leave negative effects on R&D. Similarly, the enrollment in educational institutions and the number of educational institutions have positive relationship with R&D in Pakistan but the result is statistically insignificant. The results can be seen in table III.

Table III OLS Results for R&D Model

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LRGDPPC	2.187160	0.769545	2.842147	0.0076
LPTR	-1.394669	0.476525	-2.926752	0.0062
LENRHM	0.709155	0.838962	0.845277	0.4040
LEDINS	1.187428	0.850887	1.395519	0.1722
C	-10.49444	2.870710	-3.655695	0.0009

R-squared	0.952347	F-statistic	164.8782	LM Stat
Adj R-squared	0.946571	Prob(F-statistic)	0.000000	

The time series data can sometimes result in misleading results if the data is found non stationary. If the data is found non stationary, then the long run relationship is checked. Therefore we are using Augmented Dickey Fuller test for stationarity. The results have been displayed in table IV and V. When the ADF test is conducted by using the assumption 'With intercept but No Trend', all variables of the study appear as non stationary at level. All variables become stationary when 1st difference is taken. Similarly, when the test is revised with the assumption of 'With Trend and Intercept', all variables are non stationary at level but they become stationary when 1st difference is taken. Once, it is found that the data is not stationary at level, and then questions arise on the validity of the OLS results. Therefore, to validate the OLS results, the long run relationship is checked. Cointegration is considered as affective tool for this purpose. Many tests are used for finding the cointegration but we are using Johansen Cointegration (1988, 1991, 1995) test as all variables are stationary at 1st difference.

The results of Johansen cointegration test for model with Real GDP per capita as dependent variable showed the existence of at most one cointegrating equation which means the existence of long run relationship of economic growth with R&D. this confirms the results of the OLS and show that the results derived from the non stationary data were not spurious. Similarly, the Johansen cointegration test results derived from the R&D model also gives at most 1 cointegrating equation. This means that the R&D is found in long run relationship with its determinants. The results can be seen in Tables VI and VII.

Table IV ADF Test Results with intercept but No Trend

Variable	Level				1st Difference			
	ADF-Statistic	Critical value		P-value	ADF-Statistic	Critical Value		P-Value
		1%	5%			1%	5%	
LRGDP	-0.7820[0]	-3.6210	-2.9434	0.8125	-5.9552 [1]	-3.6329	-2.9484	0.0000
LTLF	0.7813[1]	-3.6268	-2.9458	0.9923	-7.7544 [0]	-3.6268	-2.9458	0.0000
LHEALTH	-0.6078[0]	-3.6210	-2.9434	0.8568	-6.3426[0]	-3.6268	-2.9458	0.0000
LRD	-1.3174 [0]	-3.6210	-2.9434	0.6112	-5.1376[0]	-3.6268	-2.9458	0.0002
LEDINS	-1.2304 [0]	-3.6210	-2.9434	0.6508	-4.8765[0]	-3.6268	-2.9458	0.0003
LPTR	-1.1162[0]	-3.6210	-2.9434	0.6991	-5.0338[0]	-3.6268	-2.94584	0.0002

The Lag Selection is as per Minimum AIC Criteria.

Table V ADF Test Results with Trend and Intercept

Variable	Level				1st Difference				Results
	ADF-Statistic	Critical value		p-value	ADF-Statistic	Critical Value		P-Value	
		1%	5%			1%	5%		
LRGDPPC	-2.1706[2]	-4.2436	-3.5443	0.4904	-5.9868[1]	-4.2436	-3.5443	0.0001	I(1)
LTLF	-2.5563[0]	-4.2268	-3.5366	0.3012	-7.7943[0]	-4.2350	-3.5403	0.0000	I(1)
LHEALTH	-2.8782[0]	-4.2268	-3.5366	0.1808	-6.2637[0]	-4.2349	-3.54032	0.0000	I(1)
LRD	-2.1337[0]	-4.2268	-3.5366	0.5109	-5.1302[0]	-4.2349	-3.54032	0.0010	I(1)
LEDINS	-0.6662[0]	-4.2268	-3.5366	0.9683	-4.8987[0]	-4.2349	-3.5403	0.0018	I(1)
LPTR	-1.3646[0]	-4.2268	-3.5366	0.8549	-5.0523[0]	-4.2349	-3.54032	0.0012	I(1)

Lag Selection is as per Minimum AIC Criteria.

Table VI Johansen Cointegration Test Results for the Model with Real GDP Per Capita as Dependent variable

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value
None *	0.584018	79.61074	69.81889
At most 1 *	0.472755	48.91180	47.85613
At most 2	0.378211	26.50868	29.79707
At most 3	0.243934	9.878269	15.49471
At most 4	0.002607	0.091357	3.841466

* denotes rejection of the hypothesis at the 0.05 level

**MacKinnon-Haug-Michelis (1999) p-values

Table VII Johansen Cointegration Test Results for the Model with R&D as Dependent variable

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.695500	93.83398	69.81889	0.0002
At most 1 *	0.530145	51.02699	47.85613	0.0244
At most 2	0.389806	23.83506	29.79707	0.2075
At most 3	0.154736	6.051862	15.49471	0.6894
At most 4	9.25E-07	3.33E-05	3.841466	0.9974

* denotes rejection of the hypothesis at the 0.05 level

**MacKinnon-Haug-Michelis (1999) p-values

Conclusion and Recommendations

This paper concentrated on the role of R&D in the economic growth of Pakistan. It is concluded on the basis of the study results that R&D is a significant determinants of economic growth in Pakistan along with physical capital, health, and labour. Similarly, Real GDP per capita and the quality of educational institutions are the factors which affect R&D significantly. Research affects economic growth positively but the sector is neglected so far in Pakistan. The expenditures on R&D are lower than other developing countries of the region. Research in agriculture and industry is needed to increase productivity. The gap between university and industry should be bridged up to materialize the research in industrial output. It is therefore, recommended to increase investment in R&D to put the economy on path of sustained growth. It is also recommended to collect and analyze quality R&D data for effective policy making in the

field of science and technology, and social sectors in Pakistan. Increase in investment in education will further accelerate R&D in Pakistan which will pave way for sustained economic growth.

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