

Impact of Health on Labour Productivity: Empirical Evidence from Pakistan

Saif Ullah¹, Maqbool H. Sial² and Muhammad Kashif Tufail³

Abstract

The current study attempts to examine the role of health status on workers' productivity by employing Autoregressive Distributed Lag (ARDL) approach by Pesaran and Shin (1999) and Pesaran et al. (2001) using data from 1980 to 2010 for Pakistan. The major concern of the study is impact of health status on productivity and estimated coefficient of health is 13.39 which is highly significant indicating that 1% increase in health status leads to increase productivity by 13.39%. The coefficient of EDU is positively related to worker productivity at 1% level of significance and indicates that workers productivity will increase by 0.18% due 1% increase in education. Inflation is affecting negatively to the workers productivity and association between workers productivity and FDI which reflects impact of technology transfer on productivity is positive but statistically insignificant which shows that technology transfer has no effect on productivity in case of Pakistan. The coefficient of life expectancy is positively related to productivity but it is statistically insignificant which depicts that life expectancy is not related to productivity in the short run.

Key Words: Health, Workers productivity, ARDL

1. Introduction

Labour force is considered as a key factor and an asset for economic growth through the channel of improved productivity, furthermore investment in human capital is key driver of growth. Economic growth of a country is largely dependent on health capital and level of productivity which in turn affects growth. People with longer life are expected to save more than individuals with poor health. As a result, higher savings will contribute more in the national output leading to more investment prospects which will in turn raises output. A decline in life expectancy and ill health will retard economic growth by lessening productivity of labour. The importance of health and higher life expectancy of labour force is justified by convergence hypothesis.

According to convergence hypothesis a country with higher life expectancy will move more rapidly towards steady-state growth path than an economy with lower life expectancy. Health has been considered the foremost foundation of wealth and this importance of health capital confirms the famous notion that healthier-nations are wealthier nations (Contoyannis and Forster, 1999). Better health has positive effects on income growth as better health can improve the labor force participation rate along with the increase in labour productivity, and this will in turn raise savings in the economy. On the other hand, ill health dampens capital accumulation resulting in slow pace of income growth [Bloom and Canning, 2000; Bloom et al., 2001].

The basic idea of human capital theory rests on the notion that gain in individual education and health results in an increase in individual skills and productivity improving economic activities. The basic property of capital is that it depreciates over time. Similarly like other assets health depreciates with the passage of time. In order to reestablish the health

¹ Ph.D Scholar at Department of Economics, University of Sargodha, Pakistan,
Email: saifeconomist@yahoo.com

² Dean, Faculty of Management and Administrative Science, Professor at Department of Economics, University of Sargodha, Pakistan

³ Assistant Professor BZU Lahoe Campus, Pakistan

stock there should be proper arrangements having focus on the nutrition, health care and exercise to carry on the economic activities (Grossman's, 2000). Health is positively correlated with productivity for both skilled and unskilled workers. Better health enhances worker productivity by increasing both physical and mental ability. Workers with a better health have capacity to produce more as they have longer period to work while, workers with ill health results in lower productivity also causing reduction in supply of workers (Kumar and Kober, 2012).

There are four channels through which productivity may be affected by health. Workers with good health are more energetic and can worker for longer period and getting more return. The return obtained from more additional working can be further invested in education, health and obtaining skills this will in turn increase productivity and accumulation stock. This all will result in increasing labor force participation, savings, investment in human capital and per capita income growth (Bloom and Canning, 2000).

There are several advantages of better health at micro and macro level. It is believed that better health is important source of capital accumulation as it encourages individuals for additional savings which leads to higher productivity further. The other advantage of good health is that the government can reduce health expenditure when the people are in good health and reduced expenditure can be invested for improvement of infrastructure which will results in further improvement in the productivity of the economy (Isaksson, 2007). On the one side when people are in bad health they will be unable to contribute in the output of economy and on the other side people with no earnings will unable to give taxes leading to turn down in the living standard of nation (Davis et al., 2005).

The major disadvantage of bad health at micro level is reduction in hourly working hours leading to reduction in earnings and increased cost on health care which will disturb individual budget for other creative activities like education and basic facilities that are thought to foremost foundation of development as education and income are key factors in determining health (Gupta, 2006). At macro level the empirical studies have found positive correlation between health, national income and economic growth. The studies have also confirmed that there are two way relationships between health and economic growth as economic growth acts as stimulus for good health and good health is considered key determinant of growth (Deaton, 2000).

The current study is motivated because traditionally, it has been thought that education and experience as key factors of human capital and economists have analyzed the impact of education on workers' productivity. The current study considered health as an important determinant of productivity and attempts to analyze the impact of health on productivity along with other macroeconomic variables. Earlier studies have investigated the effect of poor health on economic growth as well as on productivity for developed countries and much of the analysis are based on cross country studies so; there is need for country specific studies especially in the developing countries. Pakistan is among those developing countries where health situation is poor and health care services are inadequate. According to WHO, developing countries should spend 5% of GDP on health expenditure while Pakistan is spending less than 1% of GDP on health expenditures. In Pakistan, one third of the population is living below poverty line and poor people have frequently poor health and mostly this figure consists of labor class therefore main objective of study is to study the impact of poor health on workers' productivity. The study also attempts to fill the gap by examining relationship between workers productivity and health in the long run and shorn run. The rest of the paper is organized as follows: section 2 describes literature review and section 3 represents empirical model. Data and methodology, and results and discussion are given in section 4 and section 5 respectively. Section 6 consists of conclusion.

2. Literature Review

Knapp (2007) investigated the relationship between health and labour productivity for Italy and Denmark using height as proxy for health. The Study used different data span for Italy and Denmark. The data were obtained from international historical statistics, and EU KLEMS project published by European Union's. The methodology of study was based on Cochrane-Orcutt AR(1) regression (CORC). The study concluded that labour productivity and health are positively correlated for both Italy and Denmark.

Cole and Neumayer (2006) analyzed the impact of poor health on total factor productivity for 20 developed and 32 developing countries by using panel data from 1965 to 1995. The data were retrieved from World Bank database (2004), FAO (2000) and Barro and Lee (2000). The analysis was carried out by using 2SLS. The study found that there was significant negative relationship between total factor productivity and poor health for all the countries. Furthermore, the results suggested that inflation was negatively associated with productivity.

Bhargava, et al. (2001) analyzed the association between economic growth and health using adult survival rate as proxy for health indicator. The data were extracted from Penn World Table and World Development Indicators ranging from 1965 to 1990 for 125 developing and developed countries. The econometric methodology was based on panel unit root, fixed effect, random effects framework and Wald test for parameter stability. The study concluded that there is positive and significant association adult survival rate (ASR) and GDP. Furthermore, study found positive correlation between growth and investment to GDP ratio.

Dormont, et al. (2008) attempted to investigate the relationship between health expenditure, labor productivity and economic growth for USA and Japan and 30 OECD by utilizing data from 1970 to 2002. The study uses pooled regressions, one way fixed effect regressions and 2 way fixed effect regressions for econometric analysis. The study have also used projection model for health expenditure. The data about OECD countries have been extracted from the AGIR data set and data about USA and Japan have been collected from national sources. The study found mixed results about the correlation between health and economic growth and health expenditures have positive effect on productivity. The projection model findings revealed that huge increase from 4% to 12% in health expenditure till 2050.

Peykarjou (2011) evaluated the correlation between life expectancy fertility rate and economic growth for OIC member states using data from 2001 to 2009. The econometric model for analysis was based on random effect model. The findings revealed that coefficients were positively correlated with GDP including life expectancy and fertility rate was negatively associated with economic growth for OIC states.

Bukhari and Butt (2007) have analyzed the relationship between health expenditure, economic growth and productivity by employing VAR and ECM over the period 1972 to 2000 for Pakistan. The empirical findings concluded that health expenditure has negative impact on GDP and no association was found between health expenditure and production in Pakistan.

Umoru and Yaqub (2013) estimated the association between health and labor productivity for Nigeria. The study has utilized annual time series data over the period 1975 to 2010. The study has employed Unit root, GMM approach and Wald test for analysis of empirical findings. The results reported that there is positive and significant relationship between health and productivity of labor. Furthermore the findings concluded that education and technology are positively related to labour productivity.

3. Empirical Model

The main aim of the study is to analyze the impact of health on labour productivity by using data ranges from 1980 to 2010 for Pakistan. For this purpose model and variables are specified considering Umoru and Yaqub (2013) and tomba (2011). The earlier studies have not included variable for health when analyzing the determinants of productivity but Barro and Sala-i-Martin (1995) have suggested that health is key determinant of human capital and it should included in the analysis for developing countries therefore current study includes health in analysis. It has been found that education has significant impact on productivity and growth (Beauchemin, 2001; Blankenau and Simpson 2004). The productivity largely depends on health and education (Kalemli-Ozcan et al., 2000). The current study also includes technology transfer that has significant effect on productivity. On the basis of above mentioned studies following model is being estimated.

$$GDPPE_t = f(CPI_t, LE_t, EDUE_t, FDI_t)$$

In the model GDPPE represents GDP per person employed obtained by dividing GDP by all the person employed used as proxy for labour productivity, CPI is used to reflect the impact of inflation, health is proxied by life expectancy at birth (LE), EDUE represents education used as education expenditure as a percentage of GDP and foreign direct investment is denoted by FDI taken as a proxy for technology transfer. The above mentioned model can be written as:

$$\ln GDPPE_t = \alpha_0 + \alpha_1 \ln CPI_t + \alpha_2 \ln LE_t + \alpha_3 \ln EDUE_t + \alpha_4 \ln FDI_t + \varepsilon_t$$

In order to examine the impact of health on labor productivity over the period 1980 to 2010 for Pakistan all the variables are used in log form. Constant term is denoted by α_0 while α_i shows the percentage change in dependent variable due to 1 percent change in independent variable and error term is represented by ε_t . Based on the literature and earlier studies all the coefficients are expected to be positively related with productivity except α_1 .

4. Data and Methodology

Data on CPI were collected from International Financial Statistics database 2011, data on FDI have been taken from Handbook of Statistics 2010 and Economic survey of Pakistan (various issues) and data on education expenditure as a percentage of GDP, life expectancy and GDP per person employed have been extracted from World Development Indicator database 2012. There are various techniques of cointegration to examine the long run relationship among the macroeconomic variables. Granger (1981) presented the idea of cointegration and Engle & Granger (1987) further encouraged this idea. But Engle & Granger (1987) residual based cointegration approach has limitations; it fails to distinguish between the explanatory and dependent variable. This method provide single long run equilibrium relationship between the variables but there may be more than one equilibrium relationships among the variables, if there are more than two variables so this technique was appropriate only for two variables. Johansen and Juselius (1990) and Johansen (1995) resolve the drawbacks of E-G approach. Johansen (1995) distinguish between the exogenous and endogenous variables.

This study employs cointegration technique based on newly developed ARDL bounds testing approach by Pesaran and Shin (1999) and Peasaran et al. (2001) to analyze the effect of health on worker productivity for Pakistan by utilizing data from 1980- 2010. This technique has several advantages over the conventional techniques. The ARDL approach to cointegration yields consistent, robust and unbiased results for long run and short run coefficients. The issue of endogeneticity can be solved by employing suitable augmentation in

the two step procedure and serial correlation can be handled by incorporating different lag structure of the variables (Halicioglu, 2004).

The reason for adopting ARDL approach is due to its various advantages over traditional techniques. This technique is appropriate for small sample size and current study covers 39 annual observations so this approach will perform better in this case. On the other hand all traditional cointegration approaches depend on large sample size and are not valid for small sample (Narayan, 2005). The main advantage of this technique is that it can be adopted either variables are stationary at I(0) or I(1) or combination of both therefore there is no need for pre testing the order of integration of variables while the application of traditional approaches require that all the variables should be integrated of same order (Pesaran *et al.*, 2001). The traditional approaches involve large number of equations to be solved while this approach is easy to use and results of this technique can easily be interpreted.

The procedure of this technique involves three steps. The first stage involves the estimation of autoregressive distributed log with the inclusion of Error correction Model (ECM) by applying the procedure of Ordinary Least Square. All the variables are in first difference form and their lag are defined in the equation which is the general form of ECM model in ARDL formulation.

$$DLnGDPPE = \lambda_0 + \sum_{i=1}^{p_1} \lambda_1 \Delta LnGDPPE_{t-i} + \sum_{i=0}^{p_2} \lambda_2 \Delta LnCPI_{t-i} + \sum_{i=0}^{p_3} \lambda_3 \Delta LnLE_{t-i} + \sum_{i=0}^{p_4} \lambda_4 LnEDUE_{t-i} + \sum_{i=0}^{p_5} \lambda_5 \Delta LnFDI_{t-i} + \varphi_1 LnGDPPE_{t-1} + \varphi_2 LnCPI_{t-1} + \varphi_3 LnLE_{t-1} + \varphi_4 LnEDUE_{t-1} + \varphi_5 LnFDI_{t-1} + \varepsilon_t \dots \dots \dots (1)$$

The description of variables in the equation is provided in the previous section. Where first-differenced operator is represented by Δ and λ_0 represents constant term. The long run coefficients of one year lagged variables are denoted by λ_i and φ_i represents estimated short run coefficients. Optimal lag length is denoted by p_i . The next step is to test long run association among the one year lagged level of variables in the equation 3 by applying F-test of joint significance. The null hypothesis is that all the long run coefficients are equal to zero indicating that there is no long run association among the variable while alternative hypothesis is that there exist long run relationship among the variables.

$$H_0 : \varphi_1 = \varphi_2 = \varphi_3 = \varphi_4 = \varphi_5 = \varphi_6 = 0$$

$$H_1 : \varphi_1 \neq 0, \varphi_2 \neq 0, \varphi_3 \neq 0, \varphi_4 \neq 0, \varphi_5 \neq 0, \varphi_6 \neq 0$$

The calculated F-statistics are compared with tabulated values at different standard level of significance for deciding the cointegration. If the value of F calculated is greater than upper critical bound then null hypothesis is rejected indicating cointegration and if the value of F calculated is less than lower critical bound the null hypothesis is accepted implying no cointegration. If the value of F calculated lies between lower and upper critical bound the result is inconclusive.

If unique cointegration relationship is found then next step involves the estimation of long run coefficients by estimating long run ARDL model. The long run model is given in the following equation.

$$LnGDPPE = \alpha_0 + \psi_1 \sum_{i=1}^{p_1} LnGDPPE_{t-i} + \psi_2 \sum_{i=0}^{p_2} LnCPI_{t-i} + \psi_3 \sum_{i=0}^{p_3} LnLE_{t-i} + \psi_4 \sum_{i=0}^{p_4} LnEDUE_{t-i} + \psi_5 \sum_{i=0}^{p_5} LnFDI_{t-i} + \varepsilon_t \dots \dots \dots (2)$$

When long run coefficients are estimated the next step is to estimate the short run elasticities. The short run coefficients can be determined by estimating the following ECM model.

$$\Delta \ln GDPPE_t = \lambda_0 + \eta_0 (ECM_{t-1}) + \sum_{i=1}^p \lambda_1 \Delta \ln GDPPE_{t-i} + \sum_{i=0}^q \lambda_2 \Delta \ln CPI_{t-i} + \sum_{i=0}^r \lambda_3 \Delta \ln LE_{t-i} + \sum_{i=0}^x \lambda_4 \Delta \ln EDUE_{t-i} + \sum_{i=0}^y \lambda_5 \Delta \ln FDI_{t-i} + v_t \dots \dots \dots (3)$$

The coefficient of ECM indicates speed of adjustment towards long run equilibrium or disequilibrium of previous year which is corrected in the current year. The value of ECM should be negative and statistically significant. The current study employs cumulative sum of recursive residual (CUSUM) and cumulative sum of squared recursive residual CUSUMSQ test developed by Brown et al. (1975) to analyze the stability of short run and long run regression coefficients over the study period.

5. Results and Discussions

This section comprised the results of Augmented Dicky Fuller (ADF) test and ARDL approach. In order to avoid the spurious results time series properties of data are analyzed by using ADF unit root test. The results of ADF test with constant and trend for all the variables are presented in the table 1.

Table 5.1: Results of ADF test with constant and trend

Variables	ADF level	ADF difference
GDPPE	-1.67	-5.70*
LE	4.70	-4.06**
EDUE	-1.70	-8.22*
CPI	-5.41*	-2.62
FDI	-4.44*	-5.60

Note:*indicate 1 % and ** represents 5 % level of significance. The 1%, 5% and 10 % critical values are - 4.227, -3.536 and -3.20 for ADF test.

The results of ADF test indicate that GDPPE, LE and EDU are stationary at level as their calculated statistics are less than tabulated statistics while CPI and FDI rejects the null hypothesis of non stationary at level. So it is concluded that some series are integrated at I(1) while others at I(0) which strongly recommended the ARDL bounds testing approach. In first step existence of long run relationship is determined through F test in which each variable is treated as dependent variable to examine the cointegration relationship. The result of F test is 4.34 when GDPPE is treated as dependent variable which is greater than upper critical bound i.e. 4.035 at 5% level of significance. So it is safe to say that long run association between GDPPE and other independents variables exists for Pakistan. When long run relationship is established among the variables, next step involves the estimation of long run and short run coefficients using ARDL approach. The choice of optimal lag structure is based on Akaike Information Criterion (AIC) and Schwarz Bayesian Criterion (SBC). The current study employs (AIC) for selection of optimal lag structure. The Equation 2 is estimated by employing ARDL (3,1,3,3,2) optimal lag structure and long run results are presented in the table given below:

Table 5.2: Long Run Coefficients using the ARDL Approach for equation 2

ARDL(3,1,3,3,2) selected based on Akaike Information Criterion (AIC)			
Dependent variable is GDPPE			
Regressors	Coefficient	Standard Error	T Ratio [Prob]
LE	13.3929	1.2233	10.9482[.000]*
EDUE	.18084	.074015	2.4432[.035]**
CPI	-.19979	.070822	-2.8210[.018]*
FDI	.11427	.0821	1.3918[.225]*
CONSTANT	-45.6502	4.7469	-9.6168[.000]*

Note: * significant at 1% ** significant at 5% and *** significant at 10%.

The major concern of the study is impact of health status on productivity and estimated coefficient of LE is 13.39 which is highly significant indicating that 1% increase in health status leads to increase productivity by 13.39%. The coefficient of EDU is positively related to worker productivity at 1% level of significance and indicates that workers productivity will increase by 0.18% due 1% increase in education. Inflation is affecting negatively to the workers productivity and association between workers productivity and FDI which reflects impact of technology transfer on productivity is positive but statistically insignificant which shows that technology transfer has no effect on productivity in case of Pakistan. These results are consistent with earlier studies conducted by [Cole and Neumayer, 2006; Bukhari and Butt, 2007; Bulman and Simon, 2003 and Umoru Yaqub, 2013] and with priori expectations.

Table 5.3: Error Correction Representation for the Selected ARDL Model

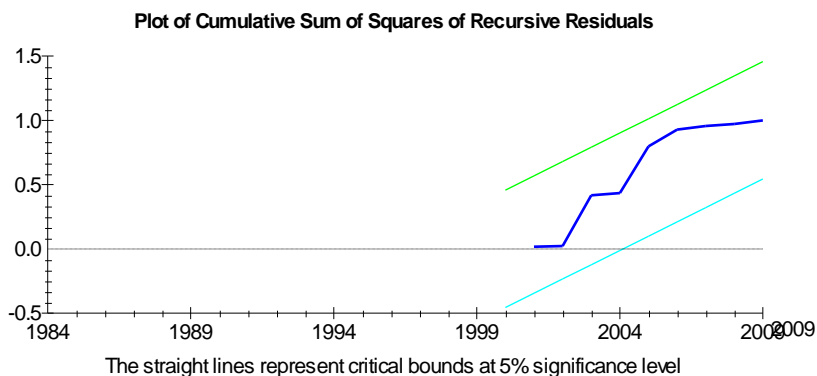
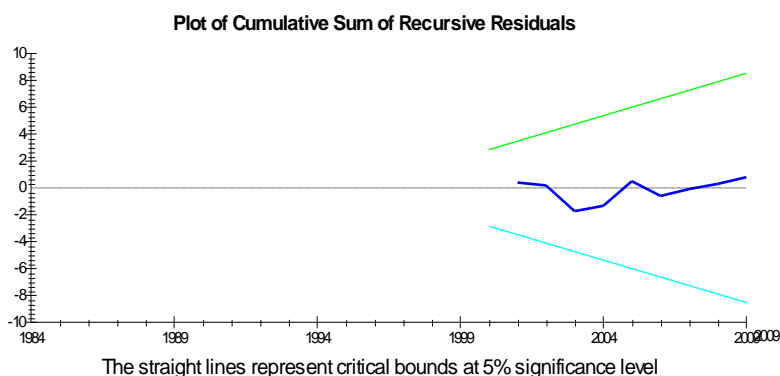
ARDL(3,1,3,3,2) selected based on Akaike Information Criterion			
Dependent variable is dGDPPE			
Regressors	Coefficient	Standard Error	T Ratio [Prob]
dGDPPE1	.099937	.23980	41676[.683]
dGDPPE2	-.24070	.19044	-1.2639[.227]
dLE	9.4406	8.0216	1.1490[.210]
dEDUE	.093052	.045559	2.0425[.060]**
dEDUE1	.11305	.082773	1.3658[.194]
dEDUE2	.13055	.053896	2.4222[.030]**
dCPI	-.50772	.32713	1.5520[.143]
dCPI1	-.51213	.28426	1.8016[.093]***
dCPI2	-1.8864	.53210	3.5451[.003]*
dFDI	-.057034	.024727	-2.3065[.037]**

dFDI1	.023470	.020051	1.1705[.261]
dINPT	-67.4867	16.6077	-4.0636[.001]*
Ecm(-1)	-0.5783	.35767	-4.1333[.001]*
R-Squared	.87270	R-Bar-Squared	.66901
S.E. of Regression	.019786	F(12, 14)	5.7126[.001]
DW-statistic	2.0823	DH –Statistics	1.67

Note: * significant at 1% ** significant at 5% and *** significant at 10%.

The coefficient of life expectancy is positively related to productivity but it is statistically insignificant which depicts that life expectancy is not related to productivity in the short run. The coefficient of ECM is 0.57 with negative sign showing that 57% of disequilibrium of previous year is corrected in current year and value of R-bar depicts that 67% variation in GDPPE is explained by the regressors. The value of DH –Statistics shows that there is no problem of auto correlation in the model.

The graphs clearly indicate that CUSUM and CUSUMSQ statistics are within the critical bounds at 5% level of significance so the null hypothesis of stable coefficients cannot be rejected. Hence, the regression coefficients are stable over the study period.



6. Conclusion

The main aim of the study is to analyze the impact of health on labour productivity by employing Autoregressive Distributed Lag (ARDL) approach by Pesaran and Shin (1999) and Pesaran et al. (2001) using data from 1980 to 2010 for Pakistan. The major concern of the study is impact of health status on productivity and estimated coefficient of LE is 13.39 which is highly significant indicating that 1% increase in health status leads to increase productivity by 13.39%. The coefficient of EDU is positively related to worker productivity at 1% level of significance and indicates that workers productivity will increase by 0.18% due 1% increase in education. Inflation is affecting negatively to the workers productivity and association between workers productivity and FDI which reflects impact of technology transfer on productivity is positive but statistically insignificant which shows that technology transfer has no effect on productivity in case of Pakistan. The coefficient of life expectancy is positively related to productivity but it is statistically insignificant which depicts that life expectancy is not related to productivity in the short run. Based on the finding the government should adopt the measures to improve the health of workers so that they may contribute to productivity. Government should enhance FDI that will contribute in improving technology which will in turn raise productivity.

References

- Barro, R. J., & Lee, J. W. (2001). International data on educational attainment: updates and implications. *oxford Economic papers*, 53(3), 541-563.
- Barro, R. J., & Sala-i-Martin, X. (1995). *Economic growth, Advanced series in economics*. New York, London and Montreal: McGraw-Hill.
- Bhargava, A., Jamison, D. T., Lau, L. J., & Murray, C. J. (2001). Modeling the effects of health on economic growth. *Journal of health economics*, 20(3), 423-440.
- Blankenau, W., & Simpson, N. (2004). Public education expenditures and growth. *Journal of Development Economics*, 73(2), 583-605.
- Bloom, D. (2000). The Health and Wealth of Nations. *Science*, 287(5456), 1207-1209.
- Bloom, David E., David Canning, and Jaypee Sevilla. *The effect of health on economic growth: theory and evidence*. No. w8587. National Bureau of Economic Research, 2001.
- Brown, R. L., Durbin, J. and Evans, M. J. (1975). Techniques for testing the constancy of regression relations over time (with discussions). *Journal of the Royal Statistical Society*, 37:149-192.
- Bukhari, S. A. H. A. S., & Butt, M. S. (2007). The direction of causality between health spending and GDP: The Case of Pakistan. *Pakistan Economic and Social Review*, 125-140.
- Bulman, T., & Simon, J. (2003). *Productivity and Inflation*. Reserve Bank of Australia.
- Cole, M., & Neumayer, E. (2006). The impact of poor health on total factor productivity. *Journal of Development Studies*, 42(6), 918-938.
- Contoyannis, P., & Forster, M. (1999). The distribution of health and income: a theoretical framework. *Journal of Health Economics*, 18(5), 605-622.
- Davis, K., Sara R. Collins, Michelle M. Doty, Alice Ho and Alyssa L. Holmgren (2005): "Health and Productivity Among U.S. Workers", *Issue Brief*, Common Wealth Fund.
- Deaton, C. (2000). Outcomes Measurement. *The Journal of Cardiovascular Nursing*, 14(4), 116-118.
- Dormont, B., Oliveira Martins, J., Pelgrin, F., & Suhrcke, M. (2008). Health expenditures, longevity and growth. *Florian and Suhrcke, Marc, Health Expenditures, Longevity and Growth*.
- Engle, R., & Granger, C. (1987). Co-Integration and Error Correction: Representation,

- Estimation, and Testing. *Econometrica*, 55(2), 251-276.
- Granger, C. (1981). Some properties of time series data and their use in econometric model specification. *Journal of Econometrics*, 16(1), 121-130.
 - Grossman, M. (2000). The human capital model. *Handbook of health economics*, 1, 347-408.
 - Gupta Indrani.(2006), “Health Investment for Economic Growth Building” Blocks for Pro-Poor Development Institute of Economic Growth, Delhi ADB Panel Discussion, Mary, 3 Hyderabad Asian Development Bank.
 - Halicioglu, F. (2004). Defense Spending and Economic Growth in Turkey: An Empirical Application of New Macroeconomic Theory. *Review of Middle East Economics and Finance*, 2(3):193-201.
 - Isaksson, A. (2007). Determinants of total factor productivity: A literature review. *Research and Statistics Branch, UNIDO*.
 - Johansen, S. (1995). *Likelihood Inference in Cointegrated Vector Auto-Regressive Models*. Oxford University Press, Oxford.
 - Johansen, S., & Juselius, K. (1990). Maximum likelihood estimation and inference on cointegration - with applications to the demand for money. *Oxford Bulletin of Economics and Statistics*, 52(2), 169-210.
 - Kalemli-Ozcan, S., Ryder, H., & Weil, D. Mortality Decline, Human Capital Investment and Economic Growth. *SSRN Journal*.
 - Knapp, D. (2007). The influence of health on labor productivity: An analysis of european conscription data. *J Ment Health*, 16(2), 157-165.
 - Kumar, A., & Kober, B. (2012). Urbanization, human capital, and cross-country productivity differences. *Economics Letters*, 117(1), 14-17.
 - Narayan, S., & Narayan, P. (2005). An empirical analysis of Fiji's import demand function. *Journal of Economic Studies*, 32(2), 158-168.
 - Pesaran, M. H. and Shin Y. (1999). *An Autoregressive Distributed Lag Modeling Approach to Co-integration Analysis. Chapter 11 in Econometrics and Economic Theory in the 20th Century: The Ragnar Frisch Centennial Symposium*, Strom S (ed.). Cambridge University Press: Cambridge.
 - Pesaran, M., Shin, Y., & Smith, R. (2001). Bounds testing approaches to the analysis of level relationships. *Journal of Applied Econometrics*, 16(3), 289-326.
 - Peykarjou, K., Gollu, R. B., Gashti, H. P., & Shahrivar, R. B. (2011). Studying the relationship between health and economic growth in OIC member states. *Interdisciplinary Journal of Contemporary Research in Business*, 3(8), 1041.
 - Tompa, E. (2002). The impact of health on productivity: empirical evidence and policy implications, *The Review of Economic Performance and Social Progress*. 181-202.
 - Umoru, D., & Yaqub, J. O. (2008). Labour productivity and health capital in Nigeria: The empirical evidence. *World, 1987(1995)*, 1995-2007.