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Estimating Health Production Function for the South Asian Countries

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Abstract The aim of this study is to estimate the health production function for the south Asian countries. The health production function expresses the functional relationship between health status and health care inputs, while life expectancy at birth has been widely used as an indicator of population health status of a country and health care inputs can be categorized into three broader categories named economic factors, social factors and environmental factors. It is a prior work to estimate health production function for the south Asian countries. A balanced panel data of seven South Asian countries are taken for the period of 1995-2015 from World Development Indicator 2017. Breusch-Pagan, Honda, King-Wu, Standardized Honda and Standardized King-Wu Lagrange Multiplier test are used to test the random effects on pooled OLS model. Hausman test is used to select the appropriate model between fixed effect and random effect model. Breusch-Pagan LM, Pesaran LM and Baltagi, Kao and Feng bias corrected scaled test are performed to check the cross-sectional dependence of the residuals. Panel Corrected Standard Error (PCSE) model has been used to deal with contemporaneous correlation in residuals. In this study health expenditure per capita and food production index are used as economic factors, education and access to improved water facilities are used as social factors and urbanization is used environmental factors. Empirical results reveal that health expenditure per capita, education, access to improved water sources and urbanization have statistical significant positive impact on life expectancy, but the impact of food production index is found statistically significantly negative in the south Asian countries. The findings of this study help the policy makers to take a suitable policy for extending life expectancy in the South Asian countries.

Keywords: *health production function, South Asian countries, life expectancy, Panel Corrected Standard Error (PCSE) model*

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1. Introduction

The conventional production function describes the mathematical or functional relationship between output and inputs and the aim of the health production function is to express the functional relationship between health output that means health status and health care inputs. We can conceptualize the framework of health production function by using Grossman's (1972) model. Grossman treated people as a producer of health who invests in health to improve it so that he or she can lead a better life, as healthy life increases utility by making feel better, and minimizes the number of day's losses due to illness which in turn increase income. Grossman build up a model to express health output as a function of health care inputs as:

$$H=F(X) \tag{1}$$

Where H= Health status

And X= vector of individual inputs to the health production function F.

Model (1) is considered as a micro model of health production function. On the basis of the theoretical consideration of this micro model later a macro model was developed where the vector of individual inputs to the health production function can be classified into three categories and express as:

$$H=F(Y,S,V) \tag{2}$$

Where H= Health status
Y= Vector of economic factors which may include economic growth, per capita income, health expenditure per capita, food production index etc.
S= Vector of social factors which may include education index, literacy or illiteracy rate, access to safe water, access to improved sanitation etc, and
V= Vector of environmental factors which may include urbanization process, environmental degradation, CO_2 emissions etc.

So, health status can be explained by a function of vector of economic, social and environmental factors. Now in empirical woks some indicators are used to express health status, for example, Auster et al. [1], McAvinchey [2], Wilkinson [3], Lin [31], use Mortality (all causes mortality), Peltzman [4], Thorton [5] use Death rate, Ngongo et al. [6], Martinez-Sanchez et al. [7], Chang and Ying [8] use Death rate at Age group, Babazono and Vissandjee [9], Filmer and Pritchett [10], Nixon and Ulmann [11] use Infant mortality rate, and Rodgers [12], Rogers and Wofford [13], Barlow and Vissandjee [14], Miller and Frech [15], Gulis [16], Macfarlane et al. [17], Kalediene and Petrauskiene [18], Veugelers et al. [19], Fayissa and Gutema [20], Shaw et al. [21], Kabir [22], Ali and Khalil [23] use Life expectancy as an indicator of health status. Most of the empirical works to estimate health production function use life expectancy to express health status.

Theoretical it is believed that economic factors like economic growth, per capita income, health expenditure per capita, food production index etc. have significant positive impact on life expectancy. Per capita income sometimes represents the affordability of a country and it is believed that high per capita income means high standard of living and high standard of living improve the quality of life by improving health. On the other hand, whose standard of living are low or who live below or near the poverty line they cannot afford appropriate nutritional food and sometimes they cannot afford the expense of quality medical care service, that's why after a certain period of their life they have more probability to fall in morbidity which can reduce the expected life years too. For this reason to extend life expectancy economic factors can play a good role.

Theoretically it is believed that some social factors like education, access to improved water sources, access to improved sanitation etc. have statistical significant positive impact on life expectancy. The impact of education on life expectancy is well established. An educated people know more about health and health related services than an uneducated people. Also an educated people is more concern about the positive or negative effect of medicine so that he can take medicine according to proper way, he is more informed about health care services, he knows about balanced diet and concern about proper nutrition and he is also free from backdated ideas related to health services. For this reason it is believed that education has significant positive impact on life expectancy. Access to improved water sources is a very crucial factor in determining life expectancy. There are lots of water borne diseases which can spread if people use water from an unhealthy source and from this reason health status can deteriorate gradually. Access to improved sanitation is also an important factor because in the absence of it many disease can spread.

Some of the most important environmental factors are urbanization process, air pollution, environmental degradation etc. While the impact of environmental degradation and air pollution are on life expectancy is expected to be negative but the expected sign of the urbanization process is ambiguous. It can be positive or negative. As rapid and unplanned urbanization process cause to degrade our environment and urban expansion creates some slum areas where standard of living and health facilities are very poor that's why in this regard it is expected that urbanization has negative impact on life expectancy. On the other hand, urbanization has some positive impact, for example, urban people have more and easy access to medical care services and doctors and most of the good hospitals are usually situated in the cities or towns. Moreover urban people are freer from superstitions than the rural people which play a vital role related to health. So theoretically impact of urbanization on life expectancy may be positive or negative.

In this study we use life expectancy, more specifically life expectancy at birth to express health status and try to investigate the economic, social and environmental determinants of life expectancy for the South Asian countries. Life expectancy at birth indicates the number of years a newborn infant would live if prevailing patterns of mortality at the time of its birth were to stay the same throughout its life [24]. According to World Bank data the average life expectancy at birth in the south Asian region in 2015 is 68.4385 which is still below the world average of 71.6759; while the life expectancy for the OECD members is 80.3186. In the south Asian region only Bangladesh, Sri-Lanka and Maldives have life expectancy above the world average. So there might be ample scope to take relevant policy to extend life expectancy in the south Asian Region. Let's see how south Asian countries are performing with respect to some socioeconomic indicators that have direct and indirect impact on life expectancy, as shown in Table 1.

Table 1. Some socioeconomic indicators and south Asian countries

Name of Countries	Life expectancy at birth, ears (2015)	Mortality rate, infant (per 1000 live births) (2015)	Improved water sources (% of population with access) (2015)	Improved sanitation facilities (% of population with access) (2015)	Health Expenditure per capita (current $) (2014)	Health expenditure per capita as a percentage of per capita GDP (2014)
Bangladesh	72.0012	30.7	86.9	60.6	30.83	2.83
India	68.3486	37.9	94.1	39.6	74.99	4.78
Pakistan	66.3769	65.8	91.4	63.5	36.155	2.74
Sri-Lanka	74.9532	8.4	95.6	95.1	127.33	3.30
Maldives	76.979	7.4	98.6	97.9	1165.12	15.10
Bhutan	69.8329	27.2	100	50.4	88.79	3.47
Nepal	69.9733	29.4	91.6	45.8	39.8682	5.70
South Asian average	68.4385	41.9	92.4002	44.7706	66.7155	4.45
OECD members	80.3186	5.85	99.306	97.768	4735.38	12.28
World average	71.6759	31.7	90.972	67.5274	1059.60	9.78

(Source: World Bank data, [24])

Average infant mortality rate per 1000 live births is very high in the south Asian region than the world average, as we see in Table 1, and it is almost 8 times higher than the OECD member countries. Infant mortality rate is very high in Pakistan, while Sri-Lanka and Maldives are doing extremely good in this indicator. Access to improved water sources is higher than world average in the south Asian region but access to improved sanitation facilities is still very poor. Compared to OECD countries, health expenditure per capita for the south Asian countries is negligible. Per capita health expenditure in the OECD member countries is $4735.38 and the world average is $1059.60, where in the south Asia it is only $66.7155. If we convert the data as health expenditure per capita as a percentage of per capita GDP then we find that it is only 4.45 percent in the south Asian region, while world average is 9.78 percent and OECD member countries average is 12.28 percent. In South Asia per capita health expenditure is only high in Maldives, as it is almost 15 percent of per capita income. So, to extend life expectancy first we have to identify the social, economic and environmental factors that have statistically significant positive impact on life expectancy for the south Asian countries and then fruitful policy should be taken.

2. Literature Review

There exists contradictory results in the previous empirical works related to estimating health production function in various countries. Some of the most important factors according to strong theoretical grounds like economic growth, income per capita, health expenditure per capita, urbanization etc. are found statistically insignificant factors in determining life expectancy in some works, again in some works these are found highly statistically significant. By analyzing 95 developing countries Rogers and Wofford [13] found that six important determinants of life expectancy are urbanization, agriculture related population, illiteracy rate, access to drinking water, average calorie intake per person and doctors per population. Barbazono and Hillman [9] by analyzing the OECD countries data for the period of 1988 found that health care expenditure per capita and outpatient and inpatient utilization are not related to health care outcomes and they found that how resources be allocated are more important than how much money is actually spent. Wilkinson [3] examined the impact of educational inequalities in life expectancy of the Lithunanian population using census data of 1989 and found strong evidence that educational inequalities exist in life expectancy that means expected life expectancy for an educated person if greater than an uneducated person. Barlow and Vissandjee [14] found that literacy, per capita income and access to safe water supplies have statistically significant positive impact on life expectancy, while fertility and tropical location have statistically significant negative impact. But they found per capita health expenditure and the process of urbanization rate appear to be weak determinants of life expectancy.

Cremieux et al. [25] analyzed the annual data from ten Canadian Provinces over 15 years and examined the relationship between health care expenditure and health outcome and found that lower health care spending is associated with statistically significant increase in infant mortality rate and a decrease in life expectancy in Canada. Filmer and Pritchett [10] used cross-national data to investigate the impact of public spending on health and found it is statistically insignificant. Miller and Frech [15] examined the data of 21 OECD countries and found Pharmaceutical consumption had a positive and statistically significant effect on remaining life expectancy at age 4 and over years, although this effect on life expectancy at birth was small and not significant. By analyzing 156 countries Gulis [16] found that per capita income, health spending, safe drinking water, calorie intake and literacy rate are the main determinants of life expectancy.

Macfarlane et al. [17] found that poverty not only excludes people from the benefits of health care system but also restricts them from participating in decisions that affect health.

Veugelers et al. [19] suggest that education is can play an important role in improving life expectancy. Fayissa and Gutema [20] estimated health production function for Sub-Saharan Africa by testing socioeconomic and environmental factors such as income per capita, illiteracy rate, food availability, urbanization rate, ratio of health expenditure to GDP and carbon dioxide emissions per capita. They found that increasing per capita income and food availability and decreasing illiteracy rate are strongly associated with life expectancy rate, but others are found little impact.

Shaw et al. [21] examined the data of OECD member countries for the period of 1960-1999 to find the factors that determine life expectancy and found that per capita use of pharmaceuticals, vegetables, fruits and butter have statistically significant positive impact on life expectancy, while tobacco and alcohol consumption have statistically significant negative impact on life expectancy. Kabir [22] investigated the socioeconomic determinants of life expectancy for the developing countries by analyzing the data of 91 developing countries using multiple regression and Probit framework. He found the most of the important factors in determining life expectancy are not statistically significant and income, education, nutritional status and public health measure have impact for only less developed countries.

Bayati, Akbarian and Kavosi [26] found that income per capita, education index, food availability, level of urbanization, employment ratio are statistically significant determinants of life expectancy for Esatern Mediterranean region. Ali and Ahmed [23] investigated the impact of food production, school enrollment, inflation, population growth, per capita income and carbon dioxide emissions per capita on life expectancy for Sultanate of Oman by analyzing time series data over the period of 1970-2012 by using ARDL approach. His study finds that food production and school enrollment have statistically significant impact on life expectancy but the impact of per capita income and inflation are found negative and statistically insignificant, while the impact on population growth rate on life expectancy on life expectancy is found statistically significantly negative.

3. Methodology of This Study

The aim of this study is to estimate the health production function for the south Asian countries. All data are collected from the World Development Indicator 2017. A balanced panel data set of seven south Asian countries named Bangladesh, India, Sri-Lanka, Nepal, Pakistan, Bhutan and Maldives over the period of 1995-2014 are used for empirical works. In this study health expenditure per capita and food production index are used as economic factors, education and access to improved water facilities are used as social factors and urbanization is used environmental factors. As economic growth, income per capita and health expenditure are highly correlated we use only health expenditure per capita because theoretically it has a direct impact on life expectancy. Health expenditure per capita is the sum of public and private health expenditures as a ratio of total population, which covers the provision of health services (preventive and curative), family planning activities, nutrition activities, and emergency aid designated for health but does not include provision of water and sanitation and expressed in current U.S. dollars [24]. Food production function is another economic factors included in this study. Food production index covers food crops that are considered edible and that contain nutrients, where Coffee and tea are excluded because, although edible, they have no nutritive value (World Bank, 2017). As theoretically and from some other previous study we find that education and access to improved water sources are very important social determinants of life expectancy that's why we include this two social factors in our study. Access to an improved water source refers to the percentage of the population using an improved drinking water source, where improved drinking water source includes piped water on premises (piped household water connection located inside the user's dwelling, plot or yard), and other improved drinking water sources (public taps or standpipes, tube wells or boreholes, protected dug wells, protected springs, and rainwater collection) (World Bank). In this study total secondary school enrollment are used as a proxy variable of education. Urbanization process is used as environmental factors in this study because it can also capture the environmental damage besides its positive impact. Urbanization process is captured by the number of urban population as a percentage of total population which is recognized as urbanization rate by World Bank. Variables, their notations and expected sign are presented in Table 2.

Table 2. Variables, their definitions and expected sign

Variable	Definition	Expected Sign
LNLE	Natural log of life expectancy	
LNHEPC	Natural log of health expenditure per capita	(+)
LNEDU	Natural log of education	(+)
LNFPI	Natural log of food production index	(+)
LNUR	Natural log of urbanization rate	(+/-)
LNAIWS	Natural log of access to improved water sources	(+)

Impact of health expenditure per capita, food production index, access to improved water sources and education on life expectancy are expected to be positive according to theoretical consideration, while impact of urbanization may be positive or negative. Logarithmic transformation of the variables have been used to get the elasticities. The estimable model of this study is:

$$LNLE = \alpha + \beta_1 LNHEPC_{it} + \beta_2 LNFPI_{it} + \beta_3 LNEDU_{it} + \beta_4 LNAIWS_{it} + \beta_5 LNUR_{it} + \varepsilon_{it} \quad (1)$$

Where i = 1, 2, 3,…, N
t = 1, 2, 3,…, T.

And ε_{it} = the error or the disturbance term.

3.1. Fixed Effect Model

To analyze the impact of the variables those are time invariant fixed effect model is used. A fixed effect model allows the intercept in the regression model to vary across cross sections but does not allow the intercept to vary across time. The relationship between independent and dependent variables is explored by this model within an entity (here country). Independent variables may or may not be influenced by the individual characteristics of each entity. The functional form of fixed model is:

$$LNLE = (\alpha + \mu_i) + \beta_1 LNHEPC_{it} + \beta_2 LNFPI_{it} + \beta_3 LNEDU_{it} + \beta_4 LNAIWS_{it} + \beta_5 LNUR_{it} + v_{it} \quad (2)$$

Where i =1, 2, 3… N

3.2. Random Effect Model

Random effect model is used to examine the differences in error variance components across time period or individual. In this model the variation across individuals (countries) is supposed to be random and uncorrelated with the explanatory variables included in the model. The functional form of random effect model is:

$$LNLE = \alpha + \beta_1 LNHEPC_{it} + \beta_2 LNFPI_{it} + \beta_3 LNEDU_{it} + \beta_4 LNAIWS_{it} + \beta_5 LNUR_{it} + (\mu_i + v_{it}) \quad (3)$$

Where i =1, 2, 3… N.

It has been assumed in a random effect model that there is no correlation between individual effect (heterogeneity) and any predictor variable. Based on this assumption the model estimates error variance specific to groups (or times).The intercept and slopes of predictor variables are finite across entity. The difference among entities (or time periods) is not reflected in their intercepts, rather it is reflected in their individual specific errors. Random effect model is often termed as error component model as is treated as a part of the composite error term.

3.3. Lagrange Multiplier Tests for Random Effects

To select the best model between simple pooled OLS and random effect model Lagrange Multiplier tests are used. In this study Breusch-Pagan, Honda, King-Wu, Standardized Honda and Standardized King-Wu this five Lagrange Multiplier test have been employed.

3.4. Hausman Test

Hausman [30] suggests a test that can be applied to the hypothesis testing problems with two different estimators. This test is called Hausman test. To select between fixed effect and random effect Model Hausman test is applied in this study.

3.5. Methods to Deal with Contemporaneous Correlation in the Model

When cross-sectional dependence or contemporaneous correlation exists in a panel data model, basic fixed effect or random effect model provides biased estimate. Therefore, in the presence of cross-sectional dependence Panel Corrected Standard Error (PCSE) model has been employed to get the unbiased results. Breusch-Pagan [27] LM test, Pesaran [28] scaled LM test and Baltagi, Feng, and Kao [29] bias-corrected scaled LM test are used to check the cross-sectional dependence in this study.

4. Results and Discussion

The descriptive statistics of the variables used in this study in terms of their mean, standard deviation, minimum and maximum values are listed in Table 3.

N, n and T represent number of total observation, number of panel ids (countries) and number of time periods respectively. Table 3 shows the results of descriptive statistics of all the variables under consideration. As panel data consists of repeated observations on the same individuals, we can find two sources of variance within the sample. It is due to the fact that each individual is systematically different from other individuals (between- individual variations) and individual's characteristics vary among observations over time (within – individual variation).

4.1. Results of Lagrange Multiplier Tests for Random Effects

To identify whether Pooled OLS model is the best model or there exists random effects we run Breusch-Pagan LM test, Honda LM test, King-Wu LM test, Standardized LM test and Standardized King-Wu LM test. Results of these LM test are summarized in Table 4.

From the results in Table 4 we see that all these tests reject the null hypothesis of no effects that means alternative hypothesis of cross section random effects exist. Therefore, Pooled OLS is not suitable for this study. Now whether fixed effect model or random effect model is appropriate for this study we have to see the results of Hausman test.

Table 3. Descriptive Statistics

Variables		Mean	Std. Dev.	Min	Max	Observations
Id	Overall	4	2.007181	1	7	N= 140
	Between		2.160247	1	7	n= 7
	Within		0	4	4	T= 20
Year	Overall	2004.5	5.786986	1995	2014	N=140
	Between		0	2004.5	2004.5	n =7
	Within		5.786986	1995	2014	T=20
LNLE	Overall	4.202117	.0722371	4.032465	4.341137	N=140
	Between		.060295	4.15441	4.286382	n =7
	Within		.0456031	4.080172	4.28862	T=20
LNHEPC	Overall	3.718119	1.082491	2.145543	7.060584	N=140
	Between		1.027309	2.659985	5.7000471	n=7
	Within		0.51056	2.567233	5.078232	T=20
LNFPI	Overall	4.566268	.1943089	4.142499	4.959693	N=140
	Between		.0885952	4.425731	4.646347	n=7
	Within		.1760106	4.164345	4.913054	T=20
LNEDU	Overall	14.23359	2.826187	9.18533	18.66754	N=140
	Between		3.01897	9.996356	18.21403	n =7
	Within		0.3449251	12.98319	14.55001	T=20
LNAIWS	Overall	4.456854	.0862186	4.271095	4.605324	N=140
	Between		.0662272	4.37201	4.563438	n =7
	Within		.0603915	4.311068	4.579678	T= 20
LNUR	Overall	3.239502	.3245957	2.380869	3.797337	N=140
	Between		.3157723	2.684852	3.549699	n =7
	Within		.1302047	2.886946	3.530045	T=20

Table 4. Results of Lagrange Multiplier Tests for Random Effects

Lagrange Multiplier Tests for Random Effects Null hypothesis: No effects Alternative hypothesis: Two-sided (Breusch-Pagan) and one-sided (all others) alternatives			
	Test Hypothesis		
Test	Cross-section	Time	Both
Breusch-Pagan	95.8930 (0.0000)	0.62088 (0.4307)	96.5139 (0.0000)
Honda	9.79250 (0.0000)	0.78796 (0.2154)	7.48151 (0.0000)
King-Wu	9.79250 (0.0000)	0.78796 (0.2154)	9.14058 (0.0000)
Standardized Honda	16.4788 (0.0000)	0.91902 (0.1790)	5.05698 (0.0000)
Standardized King-Wu	16.4788 (0.0000)	0.91902 (0.1790)	9.26331 (0.0000)

4.2. Results of Hausman Test

Hausman test is run to determine whether fixed effect model or random effect model provides best estimates of the variables. Table 5 shows the results of Hausman test.

Table 5. Results of Hausman test

Hausman Test	Chi-Sq Statistic	Chi-Sq d.f.	Probability
Cross-section random	15.587964	5	0.0081

The probability value of the test statistic for Hausman test is lower than 0.01 in this study. So, we can reject the null hypothesis easily. As we can rejected the null hypothesis of random effect, alternative hypothesis of fixed effect is accepted. So fixed effect model is preferred over Random effect model according to Hausman test.

4.3. Results of Cross-sectional Dependence Test

Table 6. Results of cross-section dependence test

Residual Cross-section Dependence Test Null hypothesis: No cross-section dependence (correlation) in residuals			
Test	Statistic	Degrees of freedom	Probability value
Breusch-Pagan LM	116.8304	21	0.0000
Pesaran scaled LM	14.78695		0.0000
Bias-corrected scaled LM	14.60274		0.0000

We use Breusch-Pagan [27] LM test, Pesaran [28] scaled LM test and Baltagi, Feng, and Kao [29] bias-corrected scaled LM test are used to check the cross-sectional dependence in the residuals of the fixed effect model. The results of the cross-section dependence test are presented in Table 6.

The null hypothesis of this three tests is that there is no cross-section dependence (correlation) in residuals. From Table 6 we see that the respective p-value of these three test are zero. So we can reject the null hypothesis at 0.001 percent level of significance. As we can reject the null hypothesis, so we can say that there exist cross-sectional dependence (correlation) in residuals.

4.4. Results of Estimated Models

Panel Corrected Standard Error (PCSE) model provides unbiased results in the presence of cross-sectional dependence. It also gives results by correcting auto-correlation and heteroscedasticity. The estimated results of pooled regression, fixed effect model, random effect model and PCSE model are presented at Table 7. From the estimated results of the PCSE we find that the impact of health expenditure on life expectancy is statistically significant and positive and one percent increase in health expenditure per capita, on average, will cause increase life expectancy by 0.005826 percent. This result is consistent with many other empirical findings and also consistent with our theoretical expectation because theoretically we know health expenditure per capita is an economic factor that will improve a person's health status.

It is found that the impact of education on life expectancy is statistically significant and positive, One percent increase in education, on average, will cause to increase life expectancy by 0.0276 percent. This finding is also in accordance with theoretical expectations and also consistent with many others empirical works. As, theoretically we know an educated people know more about health services, can read the guidelines of medicine including action and reaction of medicine, overcome some backdated meth of health etc. than an uneducated people, that's why education has a significant impact on life expectancy.

Table 7. Results of estimated models

Variables	Pooled Regression	Fixed Effect Model	Random Effect Model	PCSE Model
LNHEPC	.014536* (0.0569)	.005737** (0.0113)	.005956*** (0.0085)	.005826*** (0.0000)
LNFPI	-.017687 (0.6412)	-.005203 (0.3139)	-.004775 (0.3550)	-.003193*** (0.0023)
LNEDU	.011244*** (0.0004)	.031290*** (0.0000)	.028301*** (0.0000)	.027671*** (0.0000)
LNAIWS	1.00409*** (0.0000)	.264867*** (0.0000)	.269132*** (0.0000)	.252162*** (0.0000)
LNUR	.120480*** (0.0000)	.151958*** (0.0000)	.157870*** (0.0000)	.157203*** (0.0000)
Constant		2.0864*** (0.0000)	2.093771*** (0.000)	2.16808*** (0.0000)
R^2	0.2851	0.9925	0.9787	0.9980
Adj R^2	0.2638	0.9918	0.9779	0.9978

*** Significant at 1% level
** Significant at 5% level
* Significant at 10% level.

Impact of access to improved water sources on life expectancy is found statistically significant and positive. Empirical results reveal that one percent increase in access to improved water sources, on average, increase life expectancy by 0.252162 percent. In our study we find impact of this factor is higher than other factors. This is also consistent with with our theoretical expectations. The rationale behind this finding is that safe drinking water is the single most important factor for life. Moreover, if people have no access on improved water sources then there always exists the danger of water born diseases on that population. As access to improved water sources gradually increases in the south Asian countries the tendency to die from water born diseases fall gradually and increase life expectancy.

Empirical results also reveal that impact of urbanization on life expectancy is statistically significant and positive too, which is in accordance with our expectations. One percent increase in rate of urbanization process, on average will cause to increase life expectancy by 0.1572 percent. Urbanization increases life expectancy because urban people get some extra medical facilities than the rural counterpart like access to quick medical or hospital services or good doctors. Moreover urban area are freer from superstitions than the rural area. Although urban areas have some disadvantage too like per capita CO_2 emissions and per capita environmental degradation is high, rather in this study we find a positive significant impact of urbanization on life expectancy.

Finally, the impact of food production index on life expectancy is found statistically significant and negative, which is not in accordance with our theoretical expectation. Results reveal that if food production index can be reduced by one percent then, on average, life expectancy will increase by 0.0032 percent. The probable reason for this finding is that although life expectancy shows an increasing trend over the time, but food production index for some countries showed increasing trend for a certain time period but after that it started to decline dramatically. This also prove that food production function actually has no impact if we want to increase life expectancy in the South Asian countries.

The R-square of the PCSE model is 0.9980 and the adjusted R-square is 0.9978 which is almost same as R-square. Therefore, after adjusted with degress of freedom almost 99.78 percent of the total variation of the log of life expectancy can be explained by log of per capita health expenditure, log of food production index, log of education, log of access to improved water sources and log of urbanization process in the south Asian countries.

PCSE model gives the unbiased estimators by correcting cross-sectional dependence. We also check the cross-sectional dependence of PCSE model, which are tabulated in Table 8. From Table 8 we see that all the three tests can not reject the null hypothesis of no cross-sectional dependence (correlation) in residuals. Therefore, there are no cross-sectional dependence in PCSE model.

Table 8. Results of cross-sectional dependence for PCSE model

Residual Cross-section Dependence Test Null hypothesis: No cross-section dependence (correlation) in residuals			
Test	Statistic	Degrees of freedom	Probability value
Breusch-Pagan LM	10.64013	21	0.9693
Pesaran scaled LM	-1.598563		0.1299
Bias-corrected scaled LM	-1.7353		0.1021

We also check whether data are normaly distributed or not. The results of normality test are presented in Table 9.

Table 9. Normality test result

Jarque-Bera = 0.2080
Probability = 0.3125

The null hypothesis of normality test is data are normally distributed and we cannot reject the null-hypothesis at 10 percent level of significance. That means our data, which is used in this study, are normally distributed.

5. Conclusion and Policy Recommendation

Our aim of this study is to find the socio-economic and environmental determinants of life expectancy for the South Asian countries. Our results reveal that health expenditure per capita, education, access to improved water sources and urbanization are the statistically significant factors that have positive impact on life expectancy. But the impact of health expenditure per capita and education is so small, only 0.005 and 0.03 percent respectively. So these are weak determinants of life expectancy in the south Asian countries which have small influence on life expectancy. On the other hand access to improved water sources is the most important factor to extend life expectancy which has the elasticity of 0.25, and urbanization is the second most important factor which has elasticity equal to 0.16. Although the impact of food production function is statistically significantly negative its elasticity is very small too, which is only -0.003. So, our main focus variable should be access to improved water sources and urbanization process to extend life expectancy in the South Asian countries and policy makers should take this findings into their consideration when they take any policy to improve life expectancy.

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