Investigating the impact of CO_2 emission and economic factors on infants health: a case study for Pakistan

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ABSTRACT – REZUMAT

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This study has attempted to investigate the consequences of CO_2 emissions on infants' health in Pakistan over the period of 1975 to 2013. Several economic factors have been employed in our analysis and the estimates show insignificant impact of CO_2 emissions in affecting children mortality. Increasing health facilities lowers children mortality over a short period were also observed but the relationship inversed in the long-run. In short-run, urbanization appeared as a decreasing factor to children mortality. While income inequality remains inversely related with children mortality. Both poverty and fertility are found enhancing factors to children deaths. The poor sector of the economy seemed to observe higher children mortality due to inadequate health facilities and low standards of living. Overall, we have observed greater impact of economic factors in explaining children mortality than CO_2 emissions in case of Pakistan. These issues have a significant impact on the representative industries in Pakistan, such as the cotton textile and traditional clothing industry (apparel manufacturing).

Keywords: *CO_2 emissions, economic factors, environment, infants health, Pakistan, children mortality, textile industry*

Investigarea impactului emisiilor CO_2 și a factorilor economici asupra sănătății infantile: un studiu de caz din Pakistan

Acest studiu empiric a analizat consecințele emisiilor de CO_2 asupra sănătății infantile din Pakistan în perioada 1975–2013. Anumiți factori economici au fost utilizați în analiza realizată și estimările arată un impact nesemnificativ al emisiilor de CO_2 asupra mortalității copiilor. Creșterea numărului de facilități de sănătate scade rata mortalității infantile pe o perioadă scurtă de timp, dar această relație s-a inversat pe termen lung. Pe termen scurt, urbanizarea a apărut ca un factor cu influență descrescătoare privind evoluția mortalității infantile. Pe de altă parte, inegalitatea veniturilor rămâne invers corelată de mortalitatea infantilă. Atât sărăcia, cât și fertilitatea au rezultat ca fiind factori care ameliorează rata mortalității infantile. Sectorul economic subdezvoltat evidențiază o mortalitate infantilă mai ridicată din cauza instituțiilor sanitare inadecvate și a nivelului de trai scăzut. În general, am observat un impact mai mare al factorilor economici în explicarea mortalității infantile comparativ cu impactul emisiillor de CO_2 în cazul Pakistanului. Aceste probleme au un impact semnificativ asupra industriilor reprezentative din Pakistan, cum ar fi industria produselor textile din bumbac și industria de îmbrăcăminte tradițională.

Cuvinte cheie*: emisii de CO_2, factori economici, mediul înconjurător, mortalitatea infantilă, sistemul de sănătate, Pakistan, industria textilă*

INTRODUCTION

A historical review of the developing nations provides widening disparities in children mortality. The gap in best and worst performance regarding mortality was about 7 in 1960's that extend to 15 by 1980's. However, the progress of Middle East was better than African regions [1]. In terms of overall health, the situation is even bitter in developing regions. In African and South-East Asian countries, number of children who died in 1999 before attaining the age of five years was 15 and 6.7 in terms of percentages respectively [2]. Poor economic performance of 1980's was considered the cause of such increase in child mortality during 1990's among developing countries. For the same period child mortality decreased in rich economies while poor countries suffered high mortality rate [3]. Child mortality (less than five years) was increased in 106 countries from 1990 to 2000 [4]. The progress in attaining Millennium development goals regarding health was also different among economies. The estimated decline in child mortality was 4.2% annually from 1990 to 2015 but developing countries could attain nearly 2.5% level by 2007 [5]. This issue was discussed by researchers in cross countries and some particular regional studies.

Pakistan's economy is based on the textile industry sector which is the largest and most productive. Moreover, the textile sector makes a major contribution to reducing unemployment and sustaining a decent standard of living. Implicitly, the empirical

results obtained in this research study have an impact on the level of understanding of this representative sector dynamics. The economic factors which were analysed are significant in Pakistan.

Many economic and environmental factors were also discussed to explain such disastrous situation. Global climate change was found one of the factors influencing health. Black carbon and other particulate matters were considered disrupting our environment and became a cause of premature deaths although, the increasing mortality and air pollution in Asia and Africa could be controlled by decreasing black carbon and methane emissions [6]. CO_2 emissions do contribute in climate change and global warming as well [7]. The anthropocentric goals have made environment unhealthy. Human activities emit pollutants that cause air pollution. It has deep effects on human health through diseases from respiration problems to lungs cancer [8]. Further, goods produced have deep carbon dioxide emissions that last for many years. All these factors have polluted our environment to a considerable extent and created alarming hazards. Health hazards are among the major consequence of pollution. At one place technology has revealed cure for many diseases whereas on the other it has polluted our air through emissions that creates distinct and different diseases.

Tukker and Jansen [9] revealed that impact of manufactured products on environment is huge. A little amount of products from households involving food, appliances, construction contain over 70 percent of damage (among all products life cycle) to environment. In a way it could be stated that economic factors controlled by household incomes and expenditures play pivotal role in determining carbon emissions. The study highlights the importance of economic factors including poverty and income inequality for including in analysis. However, indoor efforts involving controlled consumption and utilization could be helpful in reducing CO_2 emissions. Through such reductions, better air could improve respiration which reduce diseases spread [10]. Schmalensee et al. [7] found CO_2 emissions and income per person are interrelated. The study provides this relationship as inverse U-shape can also be called CO_2 Kuznets curve. The increase in income of person at lower income level made more emissions than at others levels. Backlundet al. [11] pointed out the same type of relationship between income level and mortality. So, income levels are quite important determinant of emissions and health. The major part of population in developing countries earns low levels of incomes. This attracts us to find out that in a developing country like Pakistan how these income and emissions impact infant health? The literature contains fewer studies involving emissions and economic factors for explaining health in Pakistan. The present study therefore fills this gap by allowing CO_2 emissions and many economic factors along with the health facilities for elaborating their impact on health for Pakistan economy. We have found fewer roles of CO_2 emissions though whereas health facilities explain more.

THE EFFECTS OF CO_2 EMISSIONS ON HEALTH: A LITERATURE REVIEW

Discussing the impact of emissions on health there are several studies on developed and developing (emerging) countries. Nweke and Sanders III [12] found out that African people suffered severe disease burden due to emissions. Existing problems like malnutrition made situation worse for them. However, there is need of improving environmental conditions for the sake of lowering diseases and improving health. Janssen et al. [13] analysed the importance of including black carbon particles in the study of air. They found it useful indicator of air quality (comparing to other combustion particles) for evaluating health hazards. Patz et al. [14] investigated impact of climate change on health across the globe. The study used cumulative depleted CO_2 emissions per capita for quantifying global warming. Their study concluded that climate changes are increasing health dangers and poor nations are less responsible for it.

Contrarily, they are more exposed to the health hazards and could suffer more than industrialized nations. The rise in the number of elderly population, ongoing technological advancements and increase in health consciousness are fuelling the growth of global medical textiles market [15] Younger et al. [16] analysed human activities including construction, transportation and other utilizations are major source of emissions of greenhouse-gases. The use of land also found affecting environment through altering atmospheric level of CO_2. Their study recommended devising such health policies which enable to reduce climate changes and in turn improve health. Wilkinson et al. [10] examined the impact of hypothetical methods involving efficiency and environment that leads to improve infant health. The study encompassed India and UK economies. For decreasing CO_2 emissions, the main focus was driven on indoor activities ventilation, fuel utilization, stoves, etc. The empirics provide reduction of 0.6 mega tones in CO_2 emission and 850 less disability-adjusted life years (DALYs) at yearly basis (per million population). The results provided drop in infections and several diseases in India. Empirical results have provided 12500 less DALYs and reduction in CO_2 emissions in UK economy. Later Frielet al. [17] highlighted agriculture sector's impact on health in UK and Brazil economy. The study prescribed decrease in livestock consumption for reduction in heart diseases and it can decline 2850 and 2180 DALYs in UK and Brazil yearly. However, these changes have contradiction from culture or political view point of society. Woodcock et al. [18] pointed out the use of vehicles emits low carbon is beneficial for health while analysing UK (London) and India (Delhi). Adopting such measure with active travel study forecasts 7439

and 12995 less DALYs in London and Delhi respectively. This also could lower the disease in both economies. Haines et al. [19] further added climate change for analysing health. Their study recommended promotion of considering climate changes with emissions (greenhouse-gases) for devising policies about health.

Foster et al. [20] analysed relationship between air quality and mortality in Mexican economy. The study revealed increase in health costs due to air pollution and compulsory need of enforcing regulations about it. It was also highlighted that air pollution could cause bitter situation in developing economies. The cause may be bad air quality and fewer regulations along with lower monitoring capacities. Franz and FitzRoy [21] examined 61 countries and included environmental and several economic factors involving fertility and consumption of poor people. They estimate models in two stages, i.e., firstly estimate fertility using economic variables then use this estimation for estimating children mortality under 5 years. Results showed about 41% increased mortality for Central Asian Republics that possibly arise due to environmental degradation in those economies. Pakistan is a developing economy where there are no strict environmental policies implemented for the sake of enhancing economic growth. Due to its rising CO_2 emissions persistently from 1980 onwards (figure 1), the figures have reached to dangerous levels for infant health. Complementary to this, the health sector too does not get much importance from policy makers. The population increased more than 2 percent from 1970 onwards whereas the health expenditures could not attain even 1 percent of GDP during the same period (figure 2). The increase in population provides more doctors so that population per doctor is decreasing continuously (figure 3). However, the amount of existing health facilities could be explained by viewing population per bed that remained more than 1300 from 1970 to 2014 (figure 4). This is an alarming situation for the economy and needs to be addressed on urgent basis. The current study, therefore, has tried to highlight this side of the problem by incorporating both emissions and economic factors impact on health in case of Pakistan. On the other hand, Woolf and Bravemen [22] observed health conditions of US economy and advocated increase of rich share in income whereas less share of poor by 2009. That leads to lower US ranking in world about life expectancy and children mortality. Daly et al. [23] highlighted the importance of income inequality and health relation while analysing US economy through longitudinal data. The study distinguishes different levels of income distribution. Depth of poverty attached with the lower income group explains mortality more than the rich part of the society's incomes. Mortality does not appear significantly determined by inequality except for middle income people of age 25 and 64.

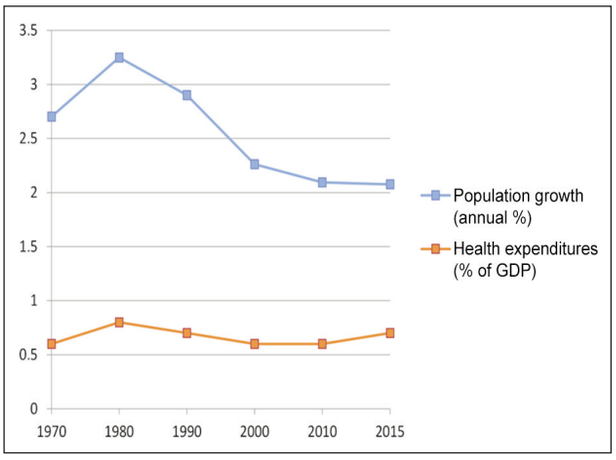

Fig. 1. Population growth and health expenditures of Pakistan [24]

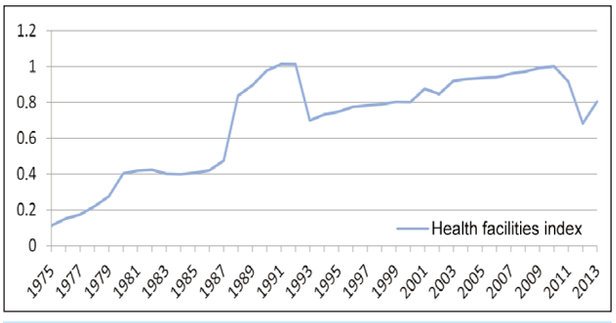

Fig. 2. The trend of Hospital facilities index

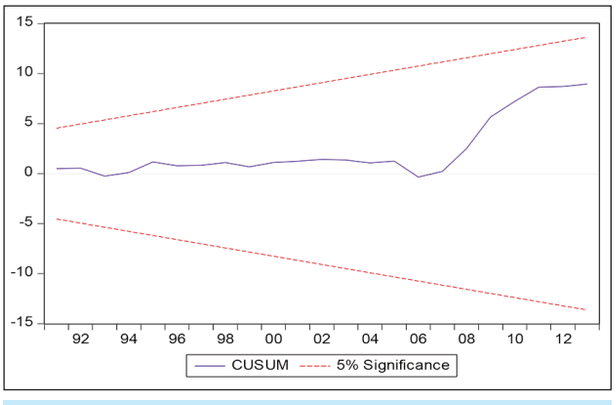

Fig. 3. Plot of Cumulative Sum (CUSUM)

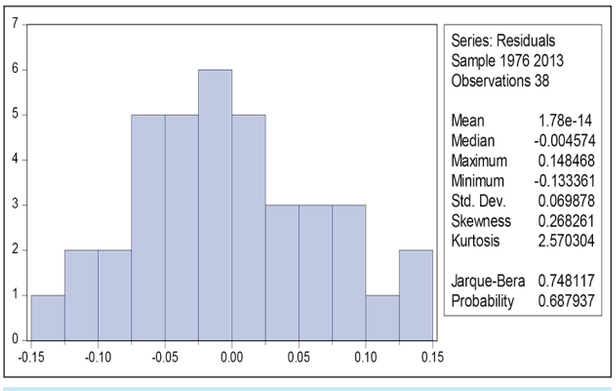

Fig. 4. Normality test for residuals

Backlundet al. [11] analysed the same economy over 1979 to 1989 to investigate relationship between mortality and income. The study concluded rising incomes are decreasing factor to mortality at lower income levels. This effect is less observed in case of higher income levels. Discussing the same economy, Cutler et al. [25] found health degrading due to rising urbanization. Urbanization enhances sanitary problems and allowed spreading more diseases among people. Farag et al. [26] investigated the important role of health expenditures on children mortality within 133 countries. Their study highlighted direct effect of good governance in controlling the usefulness of government health expenditures. This usefulness is attached with the institutions and policies of government about health. However, composition of health expenses is recommended for acquiring benefits even beyond their calculations. Rodgers [27] investigated mortality in cross-section analysis. The study involved income level and income inequality as deriving factors of health. Environmental factors and education were considered important but did not include in the study. The results showed that income inequality directly affects mortality. Larger the inequality exists more would be the mortality. Waldmann [28] established the same results. His study kept the real income of poor in countries alike. Then incomes of rich showed a strong direct relationship with infant mortality. This relationship just effected a little even after inclusion of other variables in the model. Jain et al. [29] investigated various regions of Indian economy for determining socioeconomic inequality in child mortality. Their study discovered highest rate of inequality in the most advanced regions. Crucial causes of findings were access towards maternal and children health facilities, government concentration and healthcare programs. Analysing European economies, Strittmatter and Sunde [30] also advocated healthcare improvements as decreasing factor to infant mortality. Gruber et al. [31] investigated the impact of healthcare reform 2001 in Thailand. The study found this program helpful for poor and reduced the infant mortality considerably in relatively poor provinces. It also suggested such supply-side reforms and availability of medical services to improve health situation and reducing infant's death. In an analysis on underdeveloped countries, Flegg [32] pointed out many other factors influencing child mortality other than income and income inequality. It took medical care, education (maternal) and fertility for explaining that phenomenon. When the study incorporated medical care and education along with income, its effect became insignificant. However, conclusions revealed that income distribution is more important than income. Deaton [33] also found income inequality as a determinant of mortality. Income inequality represents inappropriate environment, nutrition, sanitation, etc. for the poor countries. He observed poverty as a major cause behind child and infant mortality within developing countries. But, existing literature does not pay much attention towards various economic factors for affecting health in Pakistan. The present study is an empirical analysis of Pakistan economy that compares the impact of CO_2 emissions and various economic factors on health in case of Pakistan.

RESEARCH METHODOLOGY

The Basic aim of economic theory is to understand behaviours of economic agents by considering individuals or overall state. The basic purpose behind establishing the economic model is to elaborate the behaviour of specific phenomenon in the presence of some selected characteristics. The phenomenon is the dependant variable that is children mortality in our study whereas the characteristics are regressors under consideration. Since in real world economic factors are interrelated and there may be many that affect a single variable. However, all such factors cannot be included in a single model due to various econometric problems and for which reason the assumptions are made. Thus, in viewing the principal of parsimony, some most important factors are included in the model while the remaining factors affecting our dependent variables are assumed to be constant and their impact is united in a single value of intercept in the model. The present study includes urbanization, hospital facilities, income inequality, CO_2 emissions growth rate, poverty and fertility rate for explaining the children mortality in Pakistan. All the mentioned explanatory variables are considered important in previous researches and provide the initiative to conduct the present study. These details are discussed in the following section.

Health indicators

In simple words, health is assumed to have absence of disease. But McKeown [34] quoted: "*The World Health Organization says that health is not merely the absence of disease but an overall state of physical, mental and social well-being*" (page, 70). The effect of medicines and other cures combined must be calculated for the sake of determining health situation. McKeown prescribed the decreasing mortality as a measure of improvements in health. Mortality also appears to be able to compare the effectiveness of implementing several health facilities. Cutler et al. [25] also pointed out decreasing mortality as the measure of good health. Study further highlighted infants and children are sensitive and acquire the impact of diseases early. Ahmad et al. [2] pointed out infant mortality rate under the age of five years as better approach than infant mortality rate. It is less affected from assumptions lying in computing than mortality rate and enables to study principal diseases impact on children well. It also recommended that it can be used to analyse impact of health programmes on children as well. Patz et al. [14] analysed climate changes and health in global perspective. The study used CO_2 emissions (in form of index) for viewing

warming. Further the study quoted, "*According to the WHO, 88 % of the disease burden attributable to climate change afflicts children under age 5*" (page, 397). Since we are discussing CO_2 emissions impact on health and children are sensitive to environment. Considering these facts, we use children mortality under five years as our target variable. Woolf and Bravemen [22] surprisingly pointed out U.S. health care system as one of the cause of declining health situation. Rodgers [27] considered importance of health technology and availability for determining mortality in developing countries. Gruber et al. [31] found healthcare facilities significant in infant mortality analysis. Fuchs et al. [32] revealed health services availability mostly significant in analysing child mortality. Maternal centres in Pakistan are a source of such knowledge. Therefore, present study includes number of hospitals and maternity centres by constructing a combined index and named it as hospital facilities. Number of hospitals (HOS) can describe the general health care system. While the amount of maternity centres (MAT) provide mothers (maternal education) and children special care and it is included in the study due to selection of mortality under five years as the dependent variable. The method is described by equation 1 and results are represented in figure 2. The index ranges from 0 to 2. The value of 2 highlights best and 0 indicate worst health facilities. As a rule of thumb, its value near or greater than population growth rate may describe the better health facilities while its value close to zero describe worse health situation. Pakistan yearly population growth rate is approximately two percent or above (figure 1) while hospital facilities index remained lower than 2 (for the period of our study).

$$\left(\frac{HOSt - minHOS}{maxHOS - minHOS}\right)\beta 1 + \left(\frac{MATt - minMAT}{maxMAT - minMAT}\right)\beta 2 = \\ = HSPFACt \quad (1)$$

Many researchers including Rodgers [27], Franz and FitzRoy [21] and Flegg [32] used and suggested several economic and environmental factors to be included for mortality analysis. From their findings and suggestions, present study establishes the functional form of model as follows:

$$ChM_t = f(URB_t, CO_2gr_t, INI_t, HSPFAC_t, POV_t, FERRT_t) \quad (2)$$

where *ChM* is children mortality (infant mortality under five years per thousand live births), *URB* – urbanization (population density, people per square km of land area), CO_2gr – CO_2 emissions growth rate (annual percent), *INI* – income inequality (Gini coefficient), *HSPFAC* – hospital facilities (index of hospitals and maternity centres), *POV* – poverty (head count ratio) and *FERRT* – fertility rate, total (births per woman).

The present study includes intercept term while analysing the long run relationship among explanatory variables and explained variable. The model can be stated in the form of equation as follows:

$$ChM_t = \alpha_0 + \alpha_1 URB_t + \alpha_2 CO_2gr_t + \alpha_3 INI_t + \\ + \alpha_4 HSPFAC_t + \alpha_5 POV_t + \alpha_6 FERRT_t + e_t \quad (3)$$

The data of variables is taken from various issues of Economic Survey of Pakistan and World Bank online database. While the hospital facilities is the computed index as stated in the section of health indicators above. An initial plotting the children mortality and CO_2 emissions growth rate is shown in figure 5. This figure remains ambiguous in finding the linear pattern between them. However, the plot of hospital facilities and children mortality (figure 6) clearly identifies the inverse relationship. So, it is expected that the relationship would be decreasing between children mortality and hospital facilities, whereas no clear statement arises about the relationship of children mortality and CO_2 emissions growth rate.

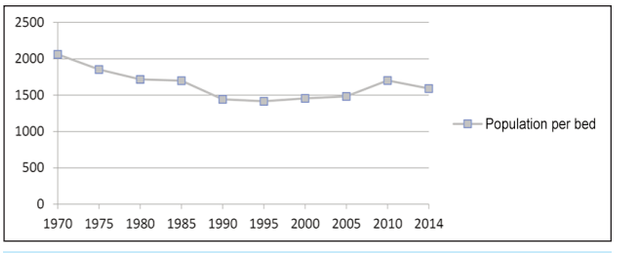

Fig. 5. Population per bed in Pakistan [36]

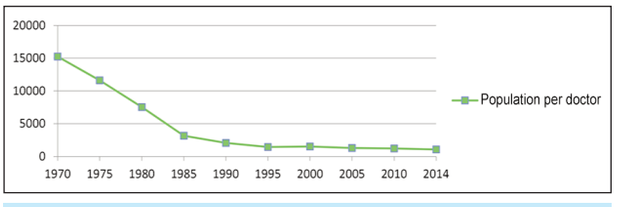

Fig. 6. Population per bed in Pakistan [36]

The econometric tools help in quantifying the economic phenomena. Most of macroeconomic factors include time trend that makes it non stationary and leads to unreliable regression results. Nelson and Plosser [37] revealed that macroeconomic variables possess unit root problem when data assessed have time series. In case, if the time series data has only negative or positive shocks, the time series data is nonstationary [38]. In literature, several unit root tests are available for testing data stationarity. The present study uses Augmented Dickey-Fuller (ADF) unit root test [39]. The general forms of the ADF can be written as:

$$X_t = X_{t-1} + \sum_{j=1}^{q} X_j X_{t-j} + e_{1t} \quad (4)$$

$$X_t = \alpha + \delta X_{t-1} + \sum_{j=1}^{q} X_j X_{t-j} + e_{2t} \quad (5)$$

$$X_t = \alpha + \beta t + \delta X_{t-1} + \sum_{j=1}^{q} X_j X_{t-j} + e_{3t} \quad (6)$$

where X_t is time series for testing unit root problem, t – the time trend and e_t – error term having white

noise properties. If $j = 0$, it represents the simple DF test. The null hypothesis acceptance provides the series has unit root, while the rejection of null hypothesis indicates the series is stationary.

Auto Regressive Distributed Lag Model (ARDL) approach to cointegration

In literature, a number of cointegration tests are available for econometric analysis. Most famous and traditional cointegration tests are the residual based Engle-Granger [40] test, Maximum Likelihood based on Johansen [41, 42] and Johansen-Juselius [43] tests. One thing is common in these tests is that they require same order of integration for their analysis. These cointegration tests become invalid and inefficient when the variables of the model have different level of integration. ARDL bound testing approach presented by Pesaran and Pesaran [44], Pesaran and Shin [45], and Pesaran, Shin and Smith [46] has numerous advantages over traditional methods of cointegration. Firstly, ARDL can be applied regardless of the order of integration. Secondly, ARDL bounds testing approach to cointegration can be used for small sample size [47]. Thirdly, this approach allows taking sufficient number of lags for capturing the data generating process in a general to specific modelling framework [48]. This technique is based on Unrestricted Vector Error Correction Model (UVECM) which has better properties for short and long-run equilibrium as compared to traditional techniques [49]. After lag order selection for ARDL procedure, simple OLS can be used for identification and estimation. Valid estimates and inferences can be drawn through the presence of unique long-run alliance that is crucial for cointegration.

$$\Delta \ln Y_t = \beta_1 + \beta_2 t + \beta_3 \ln Y_{t-1} + \beta_4 \ln X_{t-1} + \beta_5 \ln Z_{t-1} + \\ + \ldots + \sum_{h=1}^{p} \beta_h \Delta \ln Y_{t-h} + \sum_{j=0}^{p} \gamma_j \Delta \ln X_{t-j} + \\ + \sum_{k=0}^{p} \phi_k \Delta \ln Z_{t-k} + \ldots + u_{it} \quad (7)$$

At first this study finds the direction of relationship among the variables in case of Pakistan by applying the bounds test using F-Test test.

H_0: $\beta 3 = \beta 4 = \beta 5 = 0$ (no cointegration among the variables).

H_A: $\beta 3 \neq \beta 4 \neq \beta 5 \neq 0$ (cointegration among variables).

If there exists long-run cointegration relationship among the variables, then for finding short-run relationship the Vector Error Correction Model (VECM) can be utilised. The VECM is explained as under:

$$\ln Y_{it} = \beta_1 + \beta_2 t + \sum_{h=1}^{p} \beta_h \ln Y_{it-h} + \sum_{j=0}^{p} \gamma_j \ln X_{t-j} + \\ + \sum_{k=0}^{p} \phi_k \Delta \ln Z_{it-k} + ECT_{t-1} + u_t \quad (8)$$

EMPIRICAL RESULTS AND DISCUSSIONS

Temporal properties of dataset are important for analysis. Descriptive statistics is useful for such analysis. Its results are shown in table 1. The empirical estimates declare presence of positive skewness in infant mortality under five years, urbanization and poverty, whereas CO_2 emissions growth, income inequality, fertility rate and health facilities are negatively skewed. The estimates provide positive kurtosis for all variables. The individual series normality test is performed using Jarque-Bera statistic. The results of normality test affirm that data is normally distributed for all the variables involved in analysis.

Correlation matrix is presented in table 2. The correlation of infant mortality rate under five years with CO_2 emissions growth rate and fertility rate are shown positive and significant. Correlation is significant and negative in case of urbanization and hospital facilities, whereas it is insignificant for poverty and income inequality. Urbanization possesses positive and significant correlation with hospital facilities. It is negative and significant with CO_2 emissions growth rate and fertility rate. Correlation of urbanization is insignificant with income inequality and poverty.

Table 1

DESCRIPTIVE STATISTICS

Variables	ChM	URB	CO_2gr	INI	HSPFAC	POV	FERRT
Mean	128.3410	156.3253	5.2660	35.1813	0.6906	29.4492	5.3206
Median	128.3000	155.1019	6.3324	35.3569	0.7899	28.6800	5.4820
Maximum	172.0000	235.0465	13.5125	41.6788	1.0137	46.5000	6.6120
Minimum	85.6000	86.6432	–5.9437	22.2225	0.1121	20.7100	3.6820
Std. Dev.	26.9353	44.8753	4.3575	4.3585	0.2806	7.3530	1.0879
Skewness	0.0194	0.0891	–0.3496	–0.5109	–0.6528	0.5755	–0.1852
Kurtosis	1.6721	1.7935	2.6428	3.1372	2.0546	2.2957	1.3998
Jarque-Bera	2.8681	2.4168	1.0016	1.7276	4.2221	2.9589	4.3837
Probability	0.2383	0.2987	0.6060	0.4215	0.1211	0.2277	0.1117
Sum	5005.300	6096.687	205.3760	1372.070	26.9346	1148.520	207.5030
Sum Sq. Dev.	27569.33	76524.28	721.5422	721.8866	2.9925	2054.554	44.9738
Observations	39	39	39	39	39	39	39

Table 2

PAIR WISE CORRELATION							
Variables	**ChM**	**URB**	**CO_2gr**	**INI**	**HSPFAC**	**POV**	**FERRT**
ChM	1.0000						
URB	–0.9982 (–102.1057)***	1.0000					
CO_2gr	0.4704 (3.2429)***	–0.4878 (–3.3991)***	1.0000				
INI	–0.0248 –0.1512	–0.0274 –0.1670	0.2814 (1.7841)*	1.0000			
HSPFAC	–0.8177 (–8.6421)***	0.8032 (8.2022)***	–0.2641 –1.6655	0.2991 (1.9069)*	1.0000		
POV	–0.2037 –1.2657	0.2362 1.4789	–0.3830 (–2.5220)**	–0.6735 (–5.5426)***	–0.2393 –1.4995	1.0000	
FERRT	0.9846 (34.2668)***	–0.9814 (–31.1043)***	0.4751 (3.2845)***	0.00096 0.0058	–0.7488 (–6.8719)***	–0.3199 (–2.0541)**	1.0000

Note: ** and * represents significance at 5% and 10% levels respectively.

CO_2 emissions growth rate provides positive and significant correlation with income inequality and fertility rate. Correlation is negative and significant for poverty whereas insignificant for hospital facilities.

Correlation of income inequality revealed negative and significant with poverty. The correlation is positive and significant with hospital facilities and is insignificant with fertility rate. Correlation of hospital facilities with fertility rate is negative and significant, while same is insignificant with poverty. The correlation of poverty and fertility rate is revealed negative and significant. The correlation of infant mortality rate under five years that is dependant variable is revealed significant with most of the variables. The correlation matrix advocates no evidence of multicollinearity among regressors of the model.

Table 3 shows the estimates of unit root tests, ADF test is used for this purpose. The null hypothesis under consideration is that variable has a unit root. The results show infant mortality under five years, CO_2 emissions growth rate and fertility rate do not possess unit root at level. So, they are stationary at level or **I (0)** process variables. Urbanization, hospital facilities, income inequality and poverty are non-stationary at level. However, they became stationary at first difference which are **I (1)** process variables. The estimates provide mix order of integration and this is highly recommended for ARDL to be a best suitable technique for analysing cointegration.

Table 3

RESULTS OF UNIT ROOT				
Variables	**At level**		**At first difference**	
	t-statistic	**Prob.***	**t-statistic**	**Prob.***
ChM	–5.5188	0.0003	–3.8208	0.0275
URB	–0.6342	0.9705	–4.6804	0.0032
CO_2gr	–6.6548	0.0000	–5.2956	0.0007
HSPFAC	–1.6431	0.7565	–5.4666	0.0004
INI	0.1590	0.9968	–6.6435	0.0000
POV	–1.1742	0.9016	–7.8923	0.0000
FERRT	–5.8313	0.0002	–4.0400	0.0180

Note: * MacKinnon [50] one-sided p-values.

Empirics from ARDL Bounds Testing Approach

To analyse the cointegration in infant mortality rate under five years, urbanization, CO_2 emissions growth rate, hospital facilities, income inequality, poverty and fertility rate; ARDL bounds testing approach is utilized. Its results are shown in table 4. The estimated F-statistic (16.8698) is larger from upper bound at 1 percent significance level. This leads to rejection of null hypothesis of no cointegration. Results verify existence of cointegration among infant mortality rate under five years, urbanization, CO_2 emissions growth rate, hospital facilities, poverty and fertility rate. Hence, the model variables are cointegrated and we can estimate long run relationship among them.

Table 4

ARDL BOUND TESTING APPROACH		
ARDL (1, 1, 1, 1, 1, 1, 1) Dependent variable: children mortality (under five years)		
Critical values	**F-Statistic** (16.8698)***	
	Lower Bound	Upper bond
99%	3.15	4.43
95%	2.45	3.61
90%	2.12	3.23

Note: ** and * represents significance at 5% and 10% levels respectively.

The results of long run relationship among children mortality, urbanization, CO_2 emissions growth rate, hospital facilities, poverty, income inequality and fertility rate are shown in table 5. Urbanization estimate reveals negative and significant (at 1 percent level) that indicates their inverse relationship. The estimate

shows that increase in urbanization decreases the child mortality. This is supported by economic theory that urbanization leads to more facilities and thus decreases children deaths. The CO_2 emission growth rate has revealed positive and insignificant role towards children mortality. Income inequality has shown the negative and significant (at 1 percent level) relationship with children mortality. An increase in income inequality became a cause of decreasing children mortality. It resembles with Jain et al. [29] study and imply more chances of child death belongs to low-income people while fewer for rich in comparison. The health facilities are found an increasing factor to child mortality at 10 percent significance level. It seems contradictory from theory. Faraget al. [26] concluded that it is policies and institutions attached with good governance that enhances usefulness of health expenses. Our coefficient of health facilities reveals positive sign seems to occur due to volatile behaviour of government regarding health policies that is declining the effectiveness of already low resources contributed to health sector. The estimate of poverty has provided positive and significant relationship with children mortality. The increase in poor people leads to increase the children mortality. This finding is in line with Deaton [33]. Fertility coefficient has shown positive and significant (at 1 percent level) relationship with children mortality. We found increase in fertility rate provide increase in children mortality as similar to the results of Franz and Felix Fitz Roy [21]. The intercept term is rather large in our analysis. This indicates that other important factors are also playing huge role in explaining the children mortality in Pakistan. The results indicated that enhancing urbanization and income inequality became a cause of decreasing children mortality. While, hospital facilities, poverty and fertility rate are contributing factors to children mortality. The Carbon dioxide emissions are playing insignificant role in explaining children mortality in Pakistan economy.

Estimated short-run dynamics

The present study uses Vector Error-Correction Model (VECM) for analyzing short-run dynamics among children mortality, urbanization, CO_2 emissions growth rate, income inequality, hospital facilities, poverty and fertility rate for Pakistan economy. Estimated results are shown in table 6. Both urbanization and CO_2 emissions growth rate are estimated to have pos- itive and insignificant impact on children mortality. Income inequality has shown negative and significant effect on children mortality. The hospital facilities became the decreasing factor to children mortality in short-run analysis. It is contrary to long-run results. However, this immediate improvement in mortality is same as observed by Strimatter and Sunde [30]. The coefficient of poverty indicates positive and significant relationship with children mortality. This finding is similar to long-run analysis and in line to economic theory. Fertility rate has shown the positive and significant relationship with children mortality same as in long-run analysis. The short-run dynamics provide that children mortality can be decreased by controlling poverty and fertility rate whereas income inequality and hospital facilities appeared as decreasing factors to children

Table 5

ESTIMATED LONG RUN COEFFICIENTS

ARDL (1, 1, 1, 1, 1, 1, 1)
Dependent variable: children mortality (under five years) time period 1975–2013

Regressor	Coefficient	Standard-Error	T-Ratio	Prob.
URB	–0.5251	0.0340	–15.4551	0.0000
CO_2gr	0.0621	0.0366	1.6969	0.1027
INI	–0.1691	0.0352	–4.8030	0.0001
HSPFAC	1.6938	0.8398	2.0170	0.0550
POV	0.1551	0.0223	6.9638	0.0000
FERRT	3.5868	1.0877	3.2975	0.0030
C	183.7622	8.2598	22.2478	0.0000

Table 6

VECTOR ERROR-CORRECTION MODEL (VCEM)

ARDL (1, 1, 1, 1, 1, 1, 1)
Dependent variable: children mortality (under five years) time period 1975–2013

Regressor	Coefficient	Standard-Error	T-Ratio	Prob.
URB	0.1085	0.1828	0.5937	0.5582
CO_2gr	0.0091	0.0054	1.6885	0.1043
INI	–0.0364	0.0098	–3.7234	0.0011
HSPFAC	–0.3693	0.1886	–1.9586	0.0619
POV	0.0190	0.0093	2.0380	0.0527
FERRT	4.7541	0.8184	5.8088	0.0000
ECM(–1)	–0.3121	0.0721	–4.3291	0.0002

R-squared 0.9471	Adjusted R-squared 0.9184
S.E. of regression 0.0868	F-statistic 33.0365
Mean of dependent variable –2.2737	Prob(F-statistic) 0.0000
Residual sum of squares 0.1807	S.D. of dependent variable 0.3037
Akaike Info. Criterion –1.7740	Equation Log-likelihood 47.7053
Durbin-Watson statistic 1.8050	Schwarz criterion –1.1706

mortality in Pakistan. The coefficient of ECM (–0.3121) is negative and significant which is according to theoretical framework. Its value indicates the speed of adjustment from short-run towards long run equilibrium. The coefficient of ECM indicates correction of 31.21 percent per period. It also shows that short-run converges to long-run equilibrium by approximately three years and two months.

Diagnostic tests

After estimating the model, econometric problems including heteroscedasticity and autocorrelation must be discussed. Heteroscedasticity is checked using Breusch-Pagan-Godfrey. Its results are presented in table 7. The null hypothesis under consideration is absence of heteroscedasticity in the model. Since the estimated F-statistic is less than its critical value, so we do not have evidence of rejecting our null hypothesis and concludes that there is no heteroscedasticity in our computed model. Breusch-Godfrey Serial Correlation LMtest is used for checking the model for autocorrelation. Its results are shown in table 7. The null hypothesis is absence of autocorrelation in estimated model. As calculated F-statistic lies in acceptance region, so we accept our null hypothesis of no autocorrelation in our model. So, the estimated model of present study is free from both heteroscedasticity and autocorrelation.

Table 7

HETEROSCEDASTICITY TEST: BREUSCH-PAGAN-GODFREY			
F-statistic	0.6482	**Prob. F(13,24)**	0.7905
Obs*R-squared	9.8746	**Prob. Chi-Square(13)**	0.7042
Scaled Explained SS	3.0926	**Prob. Chi-Square (13)**	0.9976

Table 8

BREUSCH-GODFREY SERIAL CORRELATION LM TEST			
F-statistic	1.3542	**Prob. F(1,23)**	0.2565
Obs*R-squared	2.1129	**Prob. Chi-Square(1)**	0.1461

The economies are dynamic and economic factors keep changing over time. So, it is necessary to check that if our estimated model is shifted over time. Cumulative Sum (CUSUM) test can be used for such diagnostic. The results are presented in figure 3. The estimated model Cumulative Sum occurs in midway of critical bands. This shows that model of present study is stable. Figure 4 reports the histogram of residuals. The value of Jarque-Bera points out residuals are normally distributed. Since, there is no econometric issue regarding the results which makes the results reliable.

CONCLUSIONS

Air pollution is considered one of the biggest causes of effecting health in developing countries. We have attempted to investigate significance of relationship in CO_2 emissions and health in the presence of some other economic factors in Pakistan economy over the period from 1975 to 2013. We have used Jarque-Bera probability for estimating normality, Augmented Dickey Fuller test for checking stationarity and Auto Regressive Distributed Lag model for estimating long run relationships among variables of the model. Spulbar et al. [51] suggested that sustainable development has a significant impact on emerging countries, especially considering their characteristic features, such as: environmental degradation, social inequality, demographic dynamics, high degree of poverty, poor quality education, migration, high levels of urbanization, health system deficiencies, rapid technological change and unsustainable economic growth. Children mortality under five years is considered for analysing health. Results did not find any evidence of CO_2 emissions growth significance in affecting health in Pakistan. Urbanization appeared to be playing role in improving health over the long period of time. Estimates provide increasing income inequality as an improving factor for health whereas increase in poverty and fertility are found worsening health situation in our economy. The health facilities are found decreasing children mortality in short run whereas it became increasing factor in long run analysis. The inappropriate health facilities and economic situations have made survival difficult for children belonging to poor families. We have found children mortality explained better by economic factors than CO_2 emissions. The coefficient of ECM indicates that in three years and two months short-run converges to long-run equilibrium. More than establishing environment laws about CO_2 emissions our analysis suggests an immediate need of addressing economic factors for lowering children mortality. Poor people are suffering more and there is need to reduce poverty and improve provision of health facilities to them. So, there is need for devising poverty alleviation policies and improving access to health for poor for reducing children mortality and improving overall health dynamics in Pakistan.

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