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Research Article

THE RELATIONSHIP BETWEEN INCOME, HEALTH AND THE ENVIRONMENT

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ABSTRACT
Countries in the early phase of development do not tend to invest in environmental issues, so increasing income leads to deterioration of physical environment of a country, and also rise in pollution of water, soil, and weather. On the other hand, when environmental quality declines, it negatively impacts health; as a result, an increase in income does not necessarily lead to health improvement. In this paper, we survey the relation between health indicators, environmental variable and economic growth for 108 developing countries in 1995-2012. In this study, the Environmental Kuznets Curve EKC has been estimated by using panel data method. We estimate a two-stage least squares model that focuses on income and the environment impacts on health status, using panel vector autoregressive method to examine relation between life expectancy, CO2 and GDP growth rate. Our conclusions suggest that EKC hypothesis has not been confirmed in developing countries. Also health function estimation demonstrates that if we enter emission of CO_2 as an endogenous variable in our model, the effect of this variable on health will increase. Also estimation results using PVAR show, increase in GDP will result in higher life expectancy. Deterioration of environment, as a negative externality of economic growth, decreases the benefits of health improvements in the early phase of economic growth. Moreover, labor force in bad health condition does not increase productivity; therefore, economic growth will decline. Growth policy should be a combination of appropriate plans to protect natural environment of a country.
JEL Classification: I15, Q56, C33

Keywords: *Health Indicators, Kuznets Environmental Curve, Economic Growth, Panel 2SLS, Panel VAR*

INTUDUCTION
In 2050, world population will be 9 billion that it leads to increase in human need for energy; this factor certainly causes higher air temperature. In recent years European countries including Denmark run "Green Growth" policies, the aim of these policies is sustainable growth with decrease in environmental deterioration. Green growth means, investment in technologies which lead to production and consumption without deterioration in environment, as a result by income increasing, health will improve.
Developing countries which are in the early phases of economic growth have different status, because the loses in environmental quality and the gain in health could cancel each other out, and this challenges the idea that as income increase health would always improve.
One of the explorations for the Environmental Kuznets Curve (EKC) is that the environment can be thought of as a luxury good. In the early stages of economic development, a country would be unwilling to trade consumption for investment in environmental regulation, hence environmental quality declines. Once one country reaches a threshold level of income, its citizens start to demand improvement in environmental quality and this leads to the implementation of policies for environmental protection and eventually to reductions in pollution. Current study is trying to answer this question that, what is the connection between health indicators and environmental variables in developing countries? And what is the impact of environmental variables on health through economic growth? Corresponding to these questions it has been hypotheses that economic growth has positive impact on health indicator.
Different aspects of the present study in comparison to other related researches are:
1. In this study, PVAR model is used.
2. Interrelationship between health, environment and growth variables is examined. In the Past studies only the relation between two variables has been considered.

3. In this paper, the impact of environment on health is examined through economic growth.

The rest of the paper is organized as follows. Section 2 describes the analytical framework and the estimation methodology. Section 3 includes experimental results based on impulse-response functions and variance decomposition approach. The last section concludes.

MATERIALS AND METHODS

This paper has examined the relation between income and environment, also its effect on health for 108 developing countries in 1995-2012. Time series data gathered from world's bank. Theoretical and experimental evidences indicate that growth and economic development leads to improve in health, this improvement is facilitated by increasing in life standard including access to educational opportunities and health services. Health also relates to environmental quality such as the amount of pollution or drinking water quality. At the same time, the quality of a country's physical environment is affected by economic growth and other related factors including more intensive use of land, forest and water resources. Increase in population is another significant factor. So relationship between desired variables is presented as following model.

$$H_i = f(X_t, E_t(X_t, Z_t), W_t) \quad (1)$$

Where in: H_t is economy's health status, X_t is economic growth and related factors, E_t is the quality of its environment, W_t is social factors include preparation and access to health facilities. Z_t is used to determine the quality of environment.

To empirically analyze these issues, the following econometric model is formulated as below:

$$LE_{it} = \mu_i + \alpha'_1 GDP_{it} + \alpha'_2 CO_{2it} + \alpha'_3 ENR_{it} + \alpha'_4 HE_{it} + \alpha'_5 HB_{it} + \acute{\alpha}_6 UP_{it} + e_{it} \quad (2)$$

$$LCO_{2it} = \mu_i + \beta'_1 LGDP_{it} + \beta'_2 LGDP_{it}^{\ 2} + \beta'_3 LGDP_{it}^{\ 3} + \beta'_4 LEU_{it} + \beta'_5 LPD_{it} + e_{it} \quad (3)$$

Where in:

LE_{it}: life expectancy, GDP_{it}: economic growth rate per capita, CO_{2it}: per capita emission of CO_2, ENR_{it}: the average gross enrollment, HE_{it}: health cost per capita, HB_{it}: the number of hospital bed per capita, EU_{it}: per capita energy consumption, PD_{it}: the population density, UP_{it}: proportion of urban population.

According to the first model, health depends on three factors, including: the country's level of economic growth; the availability and accessibility of medical facilities; and the quality of the country's physical environment. The number of physician, other medical staffs, hospital beds, health care cost, also literacy rate and other factors are related to population have effect on health. Quality of environment is entered to model as an endogenous variable, urbanization as an indicator of modernization, through easy access to sophisticated medical equipment can leads to health improvement. Urbanization may put negative effects on health status, because urbanization causes overcrowding, poor hygienic level, and more diseases. Higher health quality is expected from higher educational level, since education leads to decrease in the information cost, and well educated people may have better understanding of public health infrastructures and also can better utilize these services.

Second model is EKC, where the dependence of environmental quality on economic growth is represented in a cubic relationship. The inverted-U shape EKC Requires β'_1>0, and β'_2<0. A Cubic income term is added to test the hypothesis that environmental quality tends to increase once again with high income. The Upward bend of the EKC will be obtained by β'_3(expected to be positive). In addition to income, non-income variables such as population level, literacy rate, and energy consumption have significant impact on quality of environment. For instance, a country by higher population is expected to suffer more from environmental issues because more people have to distribute available sources among themselves.

In the above model, structural equations are clearly identified, as CO_2 and LE are the only endogenous variable, while other variables (GDP, ENR, HE.HB, UP) are exogenous. Equations are estimated by 2SLS method. For more accurate analysis of relationship between life expectancy, CO_2 emission and economic growth rate, panel vector autoregressive (PVAR) approach is used. In this method, panel data approach and vector autoregressive are combined. For this purpose, following equation by P lags is presented.

$$y_{it} = \Psi_0 + A_1 y_{i,t-1} + A_2 y_{i,t-2} + ... + A_k y_{i,t-p} + \alpha_i + \lambda_t + u_{it} \quad (4)$$

In the above equation, y_{it} is K*1 vector of endogenous variables that is presented as following model:

$$y_{it} = (LE_{it}, CO2_{it}, GDP_{it})' \quad (5)$$

In the equation (4), Ψ_0 is intercept, A_j is a square matrix(K*K) of estimated coefficients of the explanatory variables, α_i is unobserved effects of sections, λ_t is time effects, u_{it} is error term, and also i= 1,2,…,n, t= 1,2,…, T indicate sections-countries and time respectively. Due to the heterogeneity of sections, fixed effect method is used.

$$y_{it} = \alpha_i + y_{i,t-i} + u \quad (6)$$

We estimate the PVAR using the fixed-effects (FE) estimator. Besides the fixed effects, the coefficient matrix A and the covariance matrix of the residuals are assumed homogeneous across Countries. Under this assumption, the pooled estimates of A can be used to compute the impulse-response functions. Confidence intervals for the impulse-response functions are computed by bootstrap simulation see Lof *et al*., (2013) for details.

RESULTS AND DISCUSSION

Most econometric models in early decades of growth were based on assumption of time series stability. After a while it was found that most of the time series are unstable, validity of structural equation and long-term relations were depend on stability of variables. Spurious regression problem may arise, if the time series variables be unstable. In the spurious regression, although, there may be no significant relation between variables, the coefficient of determinant (R^2) achieved high and will lead to incorrect inferences. To evaluate the stability of variables, there are various tests, that we choose Levin, Leen, and Cho test. In this test, H_0 is a unit root hypothesis and H_1 is regarding the stability of variables. The results of this test are given in table 1.

Table 1: results of unit root test

Levin Test	Variables
0.0017	CO_2
0.0000	HB
0.0000	ENR
0.0000	EU
0.0000	GDP
0.0000	GDP^2
0.0000	GDP^3
0.0034	PD
1.0000	HE
0.0000	LE

Resource: research results

According to the results of unit root test, all variables except health expenditure are stationary at level.
For testing the significance of individual effects (same intercepts) the F test was used. The outcomes of this test in table 2 are indicative of null hypothesis rejection and significance of individual effects, therefore heterogeneity of countries has been accepted. To determine fixed effects or random effects model, we have used the Hasman test, the result of this test indicate validity of fixed effects model.
Table 2 presents results from the estimation of the environmental equation (Eq. (2)). According to the results, all the variables except energy consumption are statistically significant. The coefficient of GDP

per capita is positive and is estimated about 12.22 %. The coefficient of squared GDP is negative which indicate that increase in national income after several steps leads to decrease in carbon dioxide emission. Third exponent of GDP is positive and is estimated about 6% which implies that in high income CO_2 emission increases again. 10% increase in population density leads to 88% increase in CO_2 emission. The estimated equation is rewritten as below:

$$LCO_{2\,it} = \mu_i + 12.22LGDP_{it} - 1.55\,LGDP_{it}^{\,2} + 0.06LGDP_{it}^{\,3} + 0.31LEU_{it} + 0.088LPD_{it} + e_{it} \qquad (7)$$

To obtain the relation between GDP and pollution we differentiate with respect to GDP from equation 7. The derived equation has no real roots; as a result we can say there is an increasing uniform relation between two variables. Indeed estimated equation between two variables doesn't have a turning point.

Since, during this period, a lot of countries are in the early phase of economic development, economic growth leads to environmental deterioration, and higher pollution. Therefore EKC hypothesis is not confirmed in developing countries.

Table 2: Results of Kuznets Function

p-value	t-statistic	Coefficient	Explanatory Variables and Intercept
0.0009	-3.34	-31.58	Intercept
0.0016	3.16	12.22	LGDP
0.0027	-3.008	-1.55	$LGDP^2$
0.0043	2.85	0.06	$LGDP^3$
0.045	2.005	0.088	LPD
0.44	0.77	0.31	LEU
0.0000	68.04	-	F Test
0.01	-	-	Hasman Test
-	-	0.96	R^2

Resource: research results

The results of estimating equation 2 by 2SLS, and OLS methods are presented in table 3.

Table 3: Estimate of Health Function

OLS		2SLS		Explanatory Variables and Intercept
p-value	Coefficient	p-value	Coefficient	
0.0000	3.09 (51.78)	0.0000	17.23 (4.41)	Intercept
0.0578	-0.011 (-1.89)	0.0001	-.069 (-4.03)	CO_2
0.0000	0.044 (7.22)	0.0001	4.78 (4.06)	LGDP
0.0000	0.18 (11.45)	0.0000	0.15 (12.05)	ENR
0.0000	0.0085 (8.23)	0.0036	3.44 (2.98)	LHE
0.0000	0.04 (4.38)	0.0000	-0.15 (-5.14)	UP
0.0551	0.008 (1.92)	0.3876	0.30 (0.86)	HB
-	0.58	-	0.79	R^2

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In this estimation, life expectancy is used as dependent variable, and CO2 emission is entered to the model as an endogenous variable. If the endogeniety of environmental variable is ignored, the results are different. Augmented regression test of Davidson and MacKinnon (1993), implies that H0 hypothesis which considers environmental variable as an exogenous one strongly rejected.

According to 2SLS outcomes, one percent increase in CO_2 emission will lead to 0.69% decrease in life expectancy. One percent increase in LGDP rate, causes 4.48% increase in education and health expenditure also cause improvement in life expectancy. Increase in urban population leads to decrease in life expectancy in developing countries, because they have not yet reached to a phase of development that have been able to control the negative effects of urbanization on health sector. The number of physician to population also has not significant impacts on life expectancy. Results of OLS estimation indicate that ignoring the endogeniety of carbon dioxide emission leads to inconsistent and incredible results. One percent increase in CO2 emission will lead to 0.011% decrease in life expectancy; underestimating the actual estimate in 2SLS method(-0.06) correcting endogenous bias. Also LGDP and health expenditure coefficient has reduced in OLS method. The urban population variable in OLS method has moved in opposite direct that it is inconsistent with the 2SLS outcomes.

Coefficients Obtained from 2SLS estimation have expected sign and it is much greater than with OLS. These results emphasizes that the effects of environmental variables on health will increase when we consider CO_2 as an endogenous variable.

According to above, increase in GDP leads to increase in CO_2 emission and also increase in CO_2 emission leading to decrease of life expectancy. On the other hand, this implies that the life expectancy should increase. Now this is a question, how life expectancy will change? To answer this, we should calculate synchronous and net effect of CO_2 emission and GDP per capita on life expectancy. For this purpose, at first, we compute the effect of GDP per capita on CO_2 emission, and then outcomes will define as a vector in which net effects of carbon dioxide and GDP per capita are represented, so following equation is defined:

$$Z: CO_{2_{it}} = \mu_i + \beta_1^{'} LGDP_{it} + \beta_2^{'} LGDP_{it}{}^2 + \beta_3^{'} LGDP_{it}{}^3 \quad (8)$$

$$LE_{it} = \mu_i + Z \quad (9)$$

Table 4: Net effect of economic growth on life expectancy

P-Value	Coefficient	Explanatory Variables and Intercept
0.0000	56.28 (96.53)	Intercept
0.0000	4.14 (19.64)	Z Vector

Resource: research results

According to the results, positive effect of GDP on health is greater than the negative effect of CO_2 emission on it; finally increase in GDP will lead to increase in life expectancy.

To analyze the dynamic relationship among LE, GDP and CO_2, we compute the impulse-response function from an estimated PVAR. This function demonstrates response of endogenous variable to generated shocks by error term. In other word, above function displays the effect of standard deviation of interest variable on other variables in a specific period. So, according to impulse response function, outcomes of life expectancy shocks, CO_2 emission and growth rate (log-differences) of real GDP per capita are summarized in the following table:

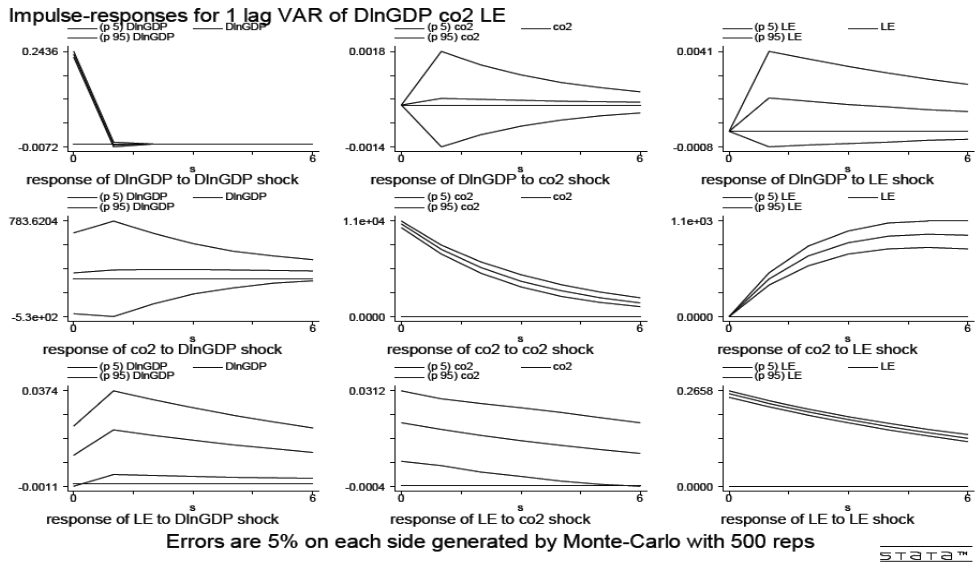

Figure 1: Impulse-response functions computed from estimated PVAR

The results of Impulse-Response function illustrate that shocks on GDP growth leads to more carbon dioxide emission. Since countries are in the early phase of development, for economic growth require more energy, so they produce more pollutants. These countries lack required infrastructure, so in the early phase of developments suffer from environmental deterioration. On the other hand, shocks on CO2 emission cause decrease in life expectancy, but net effect of GDP shocks lead to increase in life expectancy, this implies that positive effect of GDP or life expectancy outweigh the negative effect of CO_2 emission on it. Also shocks of life expectancy lead to increment in GDP that is according to the studies of world health organization (10 percent increase in life expectancy leads to gain in annual economic growth rate from 0.3 to 0.4.).

In the table 5, results of variance decomposition based on GDP growth rate, carbon dioxide emission, and life expectancy are represented.

Table 5: Variance decomposition of GDP growth rate, carbon dioxide emission, and life expectancy

	S	DlnGDP	Co2	LE
DlnGDP	10	.99976525	2.991e-.06	.00023174
Co2	10	.00039577	.97692351	.2268072
LE	10	.00720429	.00620014	.98659557
DlnGDP	20	.99973091	3.226e-.06	.00026586
Co2	20	.00048354	.96728931	.3222715
LE	20	.00735379	.006185	.98646122
DlnGDP	30	.999727	3.25e-.06	.00026975
Co2	30	.00049416	.96605195	.3345389
LE	30	.00736887	.00618329	.98644784
DlnGDP	40	.999726	3.253e-.06	.00027019
Co2	40	.00049537	.96559094	.03359523
LE	40	.00737057	.0061831	.98644634
DlnGDP	50	.99972651	3.253e-.06	.00027024
Co2	50	..00049551	.96559032	.03361132
LE	50	.00737076	.00618307	.98644617
DlnGDP	60	.9997265	3.253e-.06	.00027025
Co2	60	.00049552	.96559023	.03361315
LE	60	.00737078	.00618329	.98644615

Resource: research results

Outcomes of variance decomposition indicate that in the first period, standard deviation of GDP is completely explained by GDP, and in later periods this amount has been changed slightly. Standard deviation of carbon dioxide emission is mainly explicated by CO_2, and partly by life expectancy. The impact of carbon dioxide emission decreases over time, and the portion of life expectancy and GDP will increase. Also results display that in the first period, standard deviation of life expectancy is mainly explained by itself, and partly by the other variables. Over time, in the medium-term, and long-term, explanatory status of variables will not change significantly.

Conclusion

In the past, it was believed that economic growth through rising in income will lead to improve in life quality, but negative sides of economic growth including environmental problems have adverse impacts on human life. Economic growth requires more energy, producing more pollutant, so it can causes negative environmental effects. On the other hand high economic growth will increase the capacity to participate in the health plan. Higher per capita income causes better health through better life status including access to safe drinking water, better roads and proper nutrition. In this paper we examine the relation between health status, income and environmental indicators. For developing countries, at first, relation between income and environment was examined. Results did not confirm EKC hypothesis in these countries. Also results imply that developing countries cannot simply postpone attending to environmental concerns in the hope that the environmental will eventually improve with increased incomes. Health is a significant intervening variable and isolating the impact of environment on health especially in developing countries is very important. Also, in order to more accurate examination of relation between life expectancy, GDP growth rate, and carbon dioxide emission PVAR data approach is used. Outcomes indicate that increase in GDP growth rate leads to increase in life expectancy.

Our results show that if indirect effects of income on environment ignored, health benefit which achieved through improved income can be largely neutralized. This study shows that policymakers, who have chosen a strategy of rapid growth at the expense of the environmental deterioration, are not able to benefit from all possible profits of health from higher revenue. Also the environment deterioration causes health problems for local population. Less healthy workforce will not able to increase productivity, thus it eventuates in less revenue for the economy. Clearly, policies which focused on growth should be an appropriate combination of planes to protection of environment, and it is not in conflict with development and growth.

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