

The Relationship between Health and Environment: Econometric Analysis

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Abstract- This study explores the interrelationships between health status, environment indicator and other socioeconomic factors at the national level, using data on 80 countries in 1990, 1995, 2000 and 2005. By fixed effects specification, the study found the negative relationship between infant mortality rate and particulate matter. With better access to clean water and proper sanitation, the country tends to have lower infant mortality rate. In addition, demographic factors such as population density also show the negative impacts on infant mortality rate. Hence, there are several factors that policy makers should integrate in order to make better standard of living and health status.

Keywords- Health Status, Infant Mortality Rate, Panel Data, Particulate Matter

I. INTRODUCTION

This study focuses on the relationship between health indicators and environmental variable in cross-sections of countries. In recent years, there has been increased interest in the relationship between environment and health. We can observe that almost every human disease is influenced or caused by an environmental exposure, meaning direct human contact with a pollutant (e.g., through breathing contaminated air, drinking contaminated water, or eating a contaminant). Measurements of exposures to contaminants can help identify which pollutants may cause health problems and at what levels.

Hence, the main question of this study is whether increasing environmental stress or pollution levels reduces the health status of a country. This hypothesis reflects the impact of environment on health status holding other socio-economic factors constant.

Although there are largely analyzed related to the relationship between environment and health using cross-country data, most of those studies focus either within one country or one-one relationship which excludes other factors that affect health status such as demographic factor and prevention level. This study analyzes the link between health indicators and environmental variable for a cross-section of countries widely dispersed on the different prevention levels. Countries with lower prevention level tend to face higher impacts of pollution emission on health outcome. Because these effects could be substantial, other socio-economic factors should be considered in this study in order to make better country's health status.

II. LITERATURE REVIEWS

Good environmental quality contributes to good health. Factors such as particulate matter in the air, water pollution, and other environmental degradation damage the health of thousands of people every year. Particularly in developing countries, environmental hazards and pollution are major contributors to childhood deaths, illnesses and disability from acute respiratory disease, diarrheal diseases, physical injuries,

poisonings, insect-borne diseases and perinatal infections [1].

The links between environment and health have been examined mostly at the micro-level in epidemiological studies. There are very limited but suggestive studies at the cross country level. This is primarily due to the lack of a coherent, consistent, and comprehensive dataset describing the extent and distribution of ill health worldwide [2].

Reference [3] estimated the impact of total suspended particulates on infant mortality during 1970-1980. Reference [4] used four different methods to estimate the burden of disease due to indoor air pollution from household solid fuel use in developing countries. The study found that acute respiratory infections in children under five years of age are the largest category of deaths and disability adjusted life years from indoor air pollution. Although different health outcomes were estimated from different exposure methods, all estimations suggested that around 1.6 million deaths are associated indoor air pollution each year. Reference [5] found that both mortality and morbidity are related to outdoor air pollution in developing countries of Asia.

III. CONCEPTUAL FRAMEWORK

As mentioned earlier, not only natural environmental factors, but also socio-economic, and demographic factors must be considered to assess impacts on human health. In this study, the dependent variables are life expectancy and mortality rates in each country. The main determinants of human health have been divided into environment and socio-economic factors. For each factor, the challenge is to find specific measures, or variables, available for a large cross-section of countries across multiple years. The final dataset includes 80 countries, four years (1990, 1995, 2000, 2005).

IV. EMPIRICAL MODEL

The relationship between environmental change and human health is analyzed using panel data. Based on the literature review and conceptual framework, the empirical approach postulates that health status, H_{it} , is related to a country's environment E_{it} (such as air pollution), preventive measures Y_{it} , (such as access to safe water and sanitation), and socioeconomic factors, S_{it} (such as demographic factors). In addition, unobserved factor control variables are represented in term of time specific (τ) and country specific (ρ) effects while $i = 1, \dots, n$ province and $t = 1, \dots, T$ years. The relationships discussed above are summarized in the following general model:

$$H_{it} = f(E_{it}, Y_{it}, S_{it}; \tau, \rho)$$

The estimation consists of the following steps. I first estimate models from data pooled over time. Because each country has unique characteristics, it is important to capture unobserved country specific factors. Thus, I next estimate fixed and random effects models. For both fixed and random effects models, time dummies and time trend variables are sequentially added to the specification and tested. By examining, the relevant statistics, I determine which specification is appropriate.

V. DATA

(a) Health Status Indicators (H_{it})

The indicators of the overall health of a country's population are as follows:

- Life expectancy (LEXP) is average number of years that a newborn is expected to live if current mortality rates continue to apply. Life expectancy at birth reflects the overall mortality level of a population. It summarizes the mortality pattern that prevails across all age groups; children and adolescents, adults and the elderly. The source of LEXP data is the World Development Indicator Database (2007). World Bank

staff estimated this index from various sources including census reports, the United Nations Statistics Division's Population and Vital Statistics Report, country statistical offices, and Demographic and Health Surveys from national sources and Macro International. LEXP is often used as a health status indicator. Reference [6] used LEXP as a health indicator in Brazil to find the relationship between incomes, income disparities and illiteracy rates. Results indicated found that income disparities and illiteracy rates were negatively correlated with LEXP while GDP per capita was positively correlated with LEXP.

- Infant mortality rate (IMR) is the number of infants dying before reaching one year of age, per 1000 live births. Infant mortality is a good alternative indicator for health status because it avoids the potential reverse-causation problems associated with the relationship between adult health and income growth. IMR is obtained from the World Development Indicator Database (2007), which harmonizes estimates from WHO, UNICEF, and the World Bank, based mainly on household surveys, censuses, and vital registration, supplemented by World Bank estimates.
- Child mortality rate (CMR) is the number of children who die by the age of five, per 1,000 live births. Data on CMR come from the World Bank's World Development Indicators Database (2007)

(b) Environmental Stress Indicators (E_i)

- Particulate matter concentration (PM) are micrograms per cubic meter of

tiny particles less than 10 microns in diameter that are capable of penetrating deep into the respiratory tract and causing significant health damage. The data are from World Development Indicator Database (2007)

(c) Socio-economic Factors (S_{it})

- Population Density (POPDEN) is mid-year population divided by land area in square kilometers. The definition of population is all residents regardless of legal status or citizenship. Land area is a country's total area, excluding area under inland water bodies. The sources for estimates of land area and population data are the Food and Agriculture Organization (FAO) and World Bank, respectively. Population pressure is likely to have multiple influences. For example, it could drive up the demand for forest products and alternative land uses, and eventually lead to higher deforestation, which in turn impacts human health.
- Urban Population Density (URBAN) is the midyear population of areas defined as percent of population that is in urban area in each country (% of total) and reported to the United Nations. The data source is the World Development Indicator Database 2007, which obtains this data from World Urbanization Prospects Division of the United Nations. Urban Population Density measures the degree of urbanization.

(d) Prevention Factors (Y_{it})

- Improved Water Source (WATER) refers to the percentage of the population with reasonable access to an adequate amount of water from an improved source, such as a household connection, public standpipe, borehole, protected well or spring, or rainwater collection. This is in contrast to unimproved sources such as vendors, tanker trucks, and unprotected wells and springs. The data source is the World Development Indicator Database 2007, which obtained these data from the WHO and Meeting the MDG Water and Sanitation Target of the United Nations Children's Fund.
- Improved Sanitation Source (SANIT) refers to the percentage of the population with at least adequate access to excreta disposal facilities that can effectively

prevent human, animal, and insect contact with excreta. Improved facilities range from simple but protected pit latrines to flush toilets with a sewerage connection. The data source is the World Development Indicator Database 2007, which obtained these data from WHO and United Nations Children's Fund.

VI. RESULTS

Descriptive statistics is found in Table 1. Result of the models linking health and, environment is reported in Table 2.

As proposed in the empirical model, we estimate the model which examines the relationship between health indicators (life expectancy, infant mortality rate and child mortality rate) and all explanatory variables, such as environmental factor and socioeconomic factors.

This study estimates several versions of the empirical model. Since the pooled OLS treats the data as if it comes from a single set of data, it cannot capture the difference between different year and country. Thus, the pooled OLS specification may be inappropriate for this study. The fixed effects specification can eliminate the unobserved country-effects and unobserved time-effects from each country. The fixed effects estimator is consistent since its error term does not contain the unobserved effect from unique characteristics of each country that might be correlated with the observations. In addition, the random effects specification is applied and evaluated against the fixed effects specification by the Hausman test. For all health indicators, the the p-value of the Hausman test is lower than 0.05. Hence, the fixed effects model is preferred in this study.

As show in Table 2, the estimated coefficients of particulate matter (PM) are positive and significant at the 1% level with respect to infant mortality rate and child mortality rate. Higher particulate matter can increases both infant and child mortality

rates. The estimated coefficient of PM on life expectancy has negative sign; however, it is statistically insignificant.

In terms of prevention factors, higher access to safe water and sanitation is significantly associated with lower both infant and child mortality rates. In addition, higher access to safe water and sanitation is significantly associated with higher life expectancy. In term of socio-economic variables, the estimated coefficient of level of population density on life expectancy is positive and significant. Meanwhile, both infant and child mortality rates are inversely related with higher population density. The reason behind this is that country with higher population density sometimes offers better employment, education, and health care infrastructure which leads to better health status.

TABLE 1
DESCRIPTIVE STATISTICS

Variables	Mean	Std. Dev.	Min	Max
Life Expectancy	67.75	9.55	39.58	82.08
Infant Mortality	37.75	31.88	2.35	158.00
Child Mortality	54.15	52.94	2.79	235.00
PM	64.49	47.67	6.88	326.07
Water	84.41	17.01	13.00	100.00
Sanitation	69.04	29.46	4.00	100.00
Population Density	103.91	141.45	1.34	1177.55
Urban Population	55.90	21.06	8.50	92.30

TABLE 2
RESULTS FROM THE EMPIRICAL MODEL

Variables	LEXP		IMR		CMR	
	Coef	P-value	Coef	P-value	Coef	P-value
PM	-0.0112	0.19	0.0860	0.00	0.1407	0.00
Water	0.0841	0.03	-0.2383	0.05	-0.4691	0.01
Sanitation	0.2005	0.00	-0.6949	0.00	-0.8392	0.00
Urban Population	0.0053	0.92	-0.1639	0.33	-0.2610	0.31
Population Density	0.0292	0.00	-0.0953	0.00	-0.1700	0.00
Constant	58.3840	0.00	119.3451	0.00	174.8632	0.00

VII. CONCLUSION

This study explores the relationship between health status and environment at the national level. This study also takes a step in that direction by compiling a panel dataset and careful testing to identify the most appropriate econometric model, including fixed and random effects with country and time dummy variables.

As shown by the empirical evidence, there is the negative relationship between infant/child mortality rate and particulate matter. With better access to safe water and proper sanitation, the country tends to have lower infant/child mortality rate. Hence, there are several factors that policy makers should integrate in order to make better standard of living and health status especially environmental factors.

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