Abstract

This study examines the relationships between health, income and environment for the Philippines over the period 1990 - 2008. The study focuses on the effects of income and environment on health. It further investigates the existence of Environmental Kuznets curve (EKC) in the Philippines. To empirically analyze the issues, Ordinary Least Square (OLS) estimation was used to estimate the double-log model of health while the Maximum Likelihood Estimation (MLE) was utilized to empirically test the non-linear model of environmental Kuznets curve. The results show that CO₂ emission and real GDP positively and significantly affects health (incidence of COPD and TB) in the Philippines. The results further show that the Philippines is still on the rising portion of the inverted “U” Kuznets curve so that as income increases CO₂ emission also increases.

Keywords: Health, economic growth, environmental Kuznets curve.
INTRODUCTION

As the society moves into the 21st century, it faces its great challenges – to protect and preserve the earth’s resources as it continuous to develop economically. Environmental pollution is an important issue in the process of economic growth. The rapid growth and advancing technology that began during the Industrial Revolution took a tremendous toll on the natural environment. Mass transportation, telecommunications, manufacturing processes and synthetic chemicals are responsible for both highly advanced lifestyle that society enjoys and for much environmental degradation it now faces (Callan and Thomas, 1996).

Pollution refers to the presence of matter or energy whose nature, location or quantities have undesired effects on the environment. In particular, air pollution is the introduction of chemicals, particulate matter, or biological materials into the atmosphere that cause harm or discomfort to humans or other living organisms or cause damage to natural environment. There are two types of pollutants; natural pollutants are those contaminants that come about non-artificial process in nature while anthropogenic pollutants are those that are human induced, including all the residuals associated with the process of consumption and production (Bower, 1996).

All production generates environmental side-effects in the form of pollution, and/or depletion of natural resources. It follows that in growing economies, pressures on the environmental and natural asset based increase with the expansion of the economy, other things equal. However, it is well known that the environment-economy relationship is non-linear. While the environment-economy interactions are complex and multi-faceted, a useful conceptual tool for understanding broad trends and their underlying economic determinant is provided by the so-called Environmental Kuznets Curve (Coxhead, 2002). EKC is first observed and named after by Simon Kuznets in 1995. EKC is hypothesized to take an inverted ‘U’ shaped between income and environmental degradation – that is in the course of economic growth and development, environmental quality initially worsens but ultimately improve with the improvements in income (Grossman and Krueger, 1995, Gangadharan and Valenzuela, 2001, Ubaidillah, 2011). In such case, the relationship between GDP and environmental quality will depend on the stage of development.

The environmental degradation in turn can have a significant effect on economic activity through many channels, among which is health (Drabo, 2011). While income and environmental degradation are seen to have an inverted “U” shape relationship as explained by EKC, it is also established that health and
environment is positively or directly related (Gangadharan and Valenzuela, 2001; Barker, 2005; Drabo, 2011).

Good environmental quality contributes to good health. If people are healthy they are highly productive, thus it reflects to higher income of the country. However, factors such as carbon dioxide (CO\textsubscript{2}) in the air and other environmental pollution damage the health of thousand of people. Consequences of breathing dirty air include increased probability of heart attack, respiratory diseases like asthma, and lung cancer. Bronchitis and emphysema are common chronic conditions resulting from air pollution (Cunninghams, 2004). Also, Carbon dioxide is a greenhouse gas responsible for global warming which has adverse consequences on human health and exacerbates health risks.

In the Philippines, one of the leading causes of mortality is chronic respiratory diseases (Philippine Statistical Yearbook, 1996-2010). World Bank also reported that air pollution in the Philippines results to a yearly loss of US$1.5 billion in medical treatment in the four metropolis of Baguio, Manila, Cebu and Davao; lost wages, low productivity and 2,000 deaths (www.txtmania.com).

Rationale

The need to conduct this study lies on the fact that a developing country like the Philippines is not exempted from the crucial problem of environmental degradation. As the country aimed to develop, the tendency is to trade environmental quality for economic growth thus, putting the health of its populace at risk posed by environmental hazards. As reported, one of the leading causes of mortality in our country is chronic respiratory diseases that are linked to air pollution (NSCB, 2004).

An epidemiological study conducted by the University of the Philippines, College of Public Health, showed that the prevalence of chronic obstructive pulmonary disease (COPD) was 32.5 % among jeepney drivers, 16.4% among air conditioned bus drivers, and 13.8% among commuters (www.designofmine.com).

Most of the studies on the interactions of income, health and environment conducted were based on multi-country and this has not been thoroughly explored on a single economy like the Philippines. To mention, Gangadharan and Valenzuela (2001) and Drabo (2010) used a cross-section data and the analysis was by income groups. Deluna (2009) used a pooled data series of 43 Asian countries to analyze the relationship of income, energy efficiency and anthropogenic emission. To the best knowledge of the researchers, there has been no study about the presence of environmental Kuznets in the Philippines and explore the effects of income and environment to health. In this context, this study is conceptualized.

Objectives of the study

The main objective of the study is to analyze the interrelationships among income, health and environment in the Philippines for the period 1990-2008. Specifically, it sought to;

1. present the trends of real GDP (income), CO\textsubscript{2} emission (environment) and TB and COPD incidence (health);
2. estimate the effects of environment and income to health; and
3. to determine the presence of Environmental Kuznets Curve in the Philippines.
Significance of the Study

Environmentalists as well as policy-makers are concerned about air pollution as a result of economic growth. Research findings in this regard would be a useful instrument in the future towards maximizing both environmental and health gains that come with economic growth and development. In such case, the results of this study is useful to policy-makers particularly to the Department of Environment and Natural Resources, and National Economic and Development Authority in crafting plans and policies relevant to economic growth without sacrificing the nation's air resources and health of human capital. Result of this study is also useful as reference for future related researches.

METHODOLOGY

Theoretical Framework

One of foundations of income and environment relationship is the Environmental Kuznets Curve (EKZ) hypothesis. A Kuznets Curve is a graphical presentation of Simon Kuznets hypothesis that economic inequality increases over time while the country is developing and then after a certain average income is attained, inequality declines thus, exhibiting an inverted “U” relationship. Such relationship is also hypothesized for income and environmental quality that became a standard reference for environmental policy.

The EKZ relationship can be explained through scale, structure and pure income or abatement effect in an economy. The scale effects state that putting other things constant, higher income would result to higher pollution because of larger scale of economic activity. The structure effect claims that structural change that accompanies economic growth affects environmental quality. At lower incomes, a shift from agriculture to industry will tend to increase pollution intensity. At higher incomes, the dominant shift is from industry to services which will consequently decrease pollution intensity. In such case, as the share of industry to GDP rises then falls, environmental pollution will first rise then fall with income growth. The pure income effect assumes that environmental quality is a normal good. At low incomes, increases in income are directed towards food and shelter, and have little effect on the demand for environmental quality while at higher income levels, rising income leads to increase demand for environmental quality (Panyotou, 2003) so that at lower incomes the environmental pollution has the tendency to increase and after reaching the turning point level of income this starts to decline thus, establishing an inverted “U” relationship with income.

While income and environment are seen to have an inverted “U” relationship, it is also hypothesized that health and environment are positively related. Health is dependent to the quality of the physical environment such as amount of air pollution (Gangadharan and Valenzuela, 2001). On the other hand, it is also claimed that health of the population improved as the economy grows and develop. Such improvement is enhanced by rise in general standard of living, improved access to health services and educational opportunities so that economic growth results to better health of people in the economy.

Conceptual Framework
Figure 1 presents the relationship of three variables that interplay in the study. The arrow connecting income and health shows the causal relationship of the two variables. As previously discussed, income affects health through improvement in standard of living and better access of people to medical services and facilities. On the other hand, improvements in income (i.e., more production) pollute the environment due to the emissions coming from industries and transport facilities and this pollution directly affects the health of the population. Health expenditure is included in the model considering that this is a factor of the people’s health conditions, i.e., an increase in health expenditure improves the health condition of the people. Population is also included as a factor of environmental quality because as population increases there will be greater environmental stress as there would be more people emitting waste (Gangadharan and Valenzuela, 2001).

Statistical Analysis

Trends of Income, Health and Environment

Descriptive methods with graphical presentation using Microsoft excel is used to present the trends of income, as measured by GDP; health as represented by the incidence of chronic obstructive pulmonary diseases (COPD) and tuberculosis (TB); and environmental pollution particularly CO₂ emission.

Regression Analysis

Multiple regression is a flexible method of data analysis that may be appropriate whenever a quantitative variable (the dependent variable) is to be examined in relationship to its factors (independent or predictor variables). Relationships may be linear or nonlinear, and the independent variables may be quantitative or qualitative, and one can examine the effects of single variable or multiple variables to the other variable that is considered to be the dependent variable (Wooldridge, 2009).

A multiple regression equation for predicting Y can be expressed as follows:

$$
\text{Income} \cdot \text{Real GDP} \\
\text{Environment} \cdot \text{CO}_2 \text{ emission} \\
\text{Population} \\
\text{Health} \cdot \text{COPD & TB incidence} \\
\text{Health Exp} 
$$
\[ Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + ... + \beta_n X_n + \epsilon \]  

(3)

The parameter \( \beta_0 \) and \( \beta_i \)'s represents the y-intercept and coefficients of the relationship, respectively. In order to work with the model there is a need to satisfy the assumptions about the behavior of the error term as follows;

1. \( E(u_i) = 0 \)
2. \( E(u_i^2) = \sigma^2 \)
3. \( E(u_iu_j) = 0, i \neq j \)

(4)

(5)

(6)

where the assumption (a) states that \( u \) has a mean of zero for all \( i \). Assumptions (b) has a property of homocedasticity, where it has the same variance for all \( i \) and (c) states that there is no correlation across observation or no autocorrelation.

**Empirical Model**

Along with the theoretical and conceptual framework previously discussed, the empirical model below is formulated.

\[ H = \beta_0 + \beta_1 \text{Inc} + \beta_2 \text{Envi} + \beta_3 \text{Hexp} + \epsilon \]  

(7)

\[ \text{Envi} = \alpha_0 + \alpha_1 \text{Inc} + \alpha_2 \text{Inc}^2 + \alpha_3 \text{Pop} + \mu \]  

(8)

where;

- \( H \) = incidence of COPD and tuberculosis
- \( \text{Inc} \) = real GDP of the country
- \( \text{Envi} \) = environmental quality
- \( \text{Hexp} \) = expenditures on health
- \( \text{Pop} \) = population
- \( \epsilon \) and \( \mu \) = disturbance terms

These equations show the interaction of income, health and the environment. In Equation 7, Health is a function of income, environment, and health expenditures. Base on the theoretical framework, it is expected that \( \beta_1, \beta_2, \) and \( \beta_3 \) are all greater positive. However, increased in income is accompanied by an increase in pollution. Equation (7) is estimated using ordinary least square procedure and subjected to different functional forms like log-linear, linear-log and double log models to determine which of the function best fit the data. The criteria used to determine the best fit are the value of \( R^2 \), expected signs of the coefficients and standard deviations.

Equation 8 was used to verify the existence of the EKC. In this equation the health variable is function of income and population. Income is presented in quadratic relationship and estimated through non-linear estimation procedure. The inverted U-shaped EKC requires \( \alpha_1 \) to be positive and \( \alpha_2 \) to be negative.

**RESULTS AND DISCUSSIONS**

**Trends of CO2 Emission, Income and Incidence of COPD and TB**
Carbon dioxide emission in the Philippines, as shown in Figure 2 is erratic but exhibits an increasing trend. It has its peaks in 1996, 2000 and 2005. The highest emission was in 2005 but this made a big decline in 2006. In 2007, it started to increase again and soared up further in 2008.

![Figure 2. Carbon dioxide emission of the Philippines, 1990-2008. Source: World Bank Group Database.](image)

Figure 3 shows the combine incidence of COPD (asthma, bronchitis and other respiratory diseases) and tuberculosis in the Philippines from 1990 to 2008. These variables are utilized to represent the health because these are the common diseases caused by CO$_2$ emission in the country.

![Figure 3. COPD and tuberculosis incidence in the Philippines, 1990-2008. Source: Philippine Statistical Yearbook, NSCB](image)

According to the Philippine Health Statistics, tuberculosis (TB) is a major public health concern in the Philippines, ranking as the sixth (previously fifth) leading cause of morbidity and mortality. The agency recorded a total of 27,000 deaths from tuberculosis, at the turn of the century. As of 2004, The National Tuberculosis Program (NTP) reported 130,000 to 140,000 TB cases, of which 60% are highly infectious smear-positive cases. At the same time, the case detection rate (CDR) increased to 68% from 53% in
2003 but the cure rate also increased from 75% to 80.6% during the same period. Both are however still below global targets of 70% and 85% respectively. Meanwhile, incidence of COPD is fast rising. Chronic Obstructive Pulmonary Disease (COPD) is also one of the leading causes of deaths in the Philippines and in the world. According to World Health Organization, 12% of the Philippine population has asthma (www.doh.gov.ph). The incidence of the above mentioned diseases is erratic but increasing in trend from 1990 to 2008. It shows that the incidence was highest in 2007 but declined the following year.

The Figure 4 presents the trends of real income. It shows that it has a slight decline in 1990 to 1993 but starts to increase afterwards. It declines again in 1997-1998 during the Asian Currency Crisis but immediately regained in 1994 due to adequate policies of the Ramos administration. Years after, particularly in 2002 onwards the real income continued to increase.

![Figure 4. Real GDP per capita in the Philippines, 1990-2008.](source)

**Source:** NSO and NSCB Database.

**Relationship of Income, Health and Environment**

Table 1 presents the estimation of the effects of explanatory variables namely; income, CO$_2$ emission (environment) and health expenditures on health. The results show that income and CO$_2$ emission positively and significantly affects health, particularly the incidence of COPD and Tuberculosis (TB).

As income increases, the incidence of COPD and TB also increases. In this particular case, a 10% increase in income will lead to a 5.42% increase in the incidence of such diseases. This is against the concept that income improves health via improve health services and education. In this situation, it is apparent that the increase in Philippine income fails to halt those diseases and improved the health conditions of its constituents. This could be explained by the non-significant of the government’s expenditure to health, implying that this could be insufficient. Moreover, the Philippines could be still in the rising portion of the Environmental Kuznets Curve (EKC) so that increases in income positively affects CO$_2$ emission that leads to more incidences of COPD and TB. This is consistent to the observation that a 10% increase CO$_2$ emission leads to a 5.28% increase in COPD and TB incidence in the country. The coefficient of determination, $R^2$ indicates the predictability of the model is good. It shows that 85% of the variation in health (incidence of COPD and TB) is significantly explained by the model.
Table 1. Results of OLS estimation of health, Philippines, 1990-2008.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Estimated Coeff.</th>
<th>Std. Deviation</th>
<th>T-ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>In Incor</td>
<td>0.54191*</td>
<td>0.16973</td>
<td>3.1927</td>
</tr>
<tr>
<td>In CO₂</td>
<td>0.52806*</td>
<td>0.10393</td>
<td>5.0809</td>
</tr>
<tr>
<td>In Hexp</td>
<td>-0.8665E-01ns</td>
<td>0.2895E-03</td>
<td>-1.0059</td>
</tr>
<tr>
<td>Const</td>
<td>-1.0465</td>
<td>5120.2</td>
<td>0.8897</td>
</tr>
</tbody>
</table>

Adj. $R^2 = 84.77$

* Significant at 5% level
ns = Not significant

Environmental Kuznets Curve

Table 2 presents the results of the Environmental Kuznets Curve (EKC) estimations. As mentioned above, the environment as a variable is represented by CO₂ emission while income is expressed as real GDP. Population was included in the analyses because of the common concept that population aside from income, contributes to environmental degradation. However, it is found to be not significant at 5% level of significance.

It is also evident in Table 2 that the relationship between environment and income follows the inverted U Kuznets Curve. This is revealed by the significant positive coefficient (1076.9) of the linear income variable and negative coefficient (-3.4688) of the squared income variable. In this case the vertex or real GDP turning point is at P155, 226 million. Since the Philippine real GDP has not reach this point, (highest real GDP = P141, 895), this implies that the Philippines is still on the rising portion of the inverted "U" where as income increases, CO₂ emission also increases. Figure 5 shows the estimated or predicted values of the generated parabolic equation of the inverted "U" environmental Kuznets Curve (EKC).

Table 2. Results of the environmental estimation of Kuznets Curve using MLE, Philippines, 1990-2008.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Estimated Coeff.</th>
<th>Std. Deviation</th>
<th>T-ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Income</td>
<td>1076.9*</td>
<td>95.407</td>
<td>11.288</td>
</tr>
<tr>
<td>Income²</td>
<td>-3.468*</td>
<td>0.766</td>
<td>-4.528</td>
</tr>
<tr>
<td>POP</td>
<td>-3.982²ns</td>
<td>5.902</td>
<td>0.675</td>
</tr>
</tbody>
</table>

* Significant at 5% level
ns - Not significant
This study aims to analyze the interrelationships of real GDP, health and environment from 1990 to 2008. It is also aimed to verify the existence of the environmental Kuznets Curve (EKC) in the Philippines. To test these relationships the study used CO\textsubscript{2} emission to represent the environmental variable while health is captured by COPD and TB incidence. The trends of these economic variables were examined first before employing the proper estimation procedures. This study employed the OLS analysis in the estimation of health equation. In this case double-log form was chosen. Meanwhile, the non-linear environmental equation was estimated using Maximum Likelihood Estimation method.

The results show that health is significantly explained by real GDP and CO\textsubscript{2} emissions. The relationship is positive, meaning that as income and CO\textsubscript{2} emission increases the incidence of COPD and TB also increases. In particular, a 10\% increase in income will result to 5.42\% increase in COPD and TB incidence while a 10\% increase in CO\textsubscript{2} emission will increase COPD and TB incidence by 5.28\%. The coefficient of determination (R\textsuperscript{2}) shows that 85\% of the variation in COPD and TB incidence is explained by income and CO\textsubscript{2} emission.

The non-linear estimation of the inverted U Kuznets Curve between CO\textsubscript{2} emission and real GDP confirms the existence of the said curve in the Philippines. This is evident by the significant positive coefficient (1076.9) of the linear income variable and negative coefficient (-3.4688) of the squared income variable. The Philippines real GDP turning point is computed at P155, 226 million. At present the Philippines is at real GDP equals P144, 895 meaning the country has not reach the income level at which environmental degradation starts to decline although the country is near to it. Base on the concept of Panayotou (2003), the Philippine economy is on its early industrial stage of economic development.

Summary and Conclusion

Recommendations
Base on the findings that income and CO₂ emission are related with health the following recommendations are made.

- The Philippines should aim to increase further its real GDP. The country is still on the rising portion of the Kuznets curve and the turning point of the EKC where environmental degradation starts to decline has not been reached yet. Such will not only increase the economic status of the country but also improve the environmental condition that will eventually improve the health of its population.
- There is also a need to increase and review the country’s health spending. It was found that public health expenditure is not significant in checking the incidence of COPD and TB.
- It is also recommended to improve the country’s database. Due to limited data the study contend itself to a limited time period. The data about the environment was also very limited so that the study limits itself to CO₂ emission to represent the environment factor.

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