The Comparative Effect of Air Pollution Caused by Greenhouse Gases Emissions on the Health of Men and Women in the Upper Middle-Income Countries

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Abstract

Greenhouse gas emissions and air pollution is a heterogeneous, complex mixture of gases, liquids and particulate matter and one of the major problems in the world which threatens the health of individuals and although this factor alone does not lead to death, it is very dangerous by affecting the progress and the progress speed of some diseases. Given the importance of health, in this paper, the effect of greenhouse gas pollution will be examined on the health of men and women in 33 upper middle-income countries from 2000 to 2016 in the form of panel data.

The research results show that during the period studied, greenhouse gas pollution had a negative and significant effect on the health of men and women in the countries studied, but its effect on women's health was more than that of men.

Keywords: air pollution, Greenhouse Gas Emissions, Health, Panel Data Model

JEL Classifications: I10, Q01, Q53

1. Introduction


Air pollution has deleterious effects on both physical and mental health. (Fotourehchi, 2016) More than two million deaths per year are the direct result of air pollution through damage to the lungs and respiratory system (Shah et al. 2013). they were strongly associated with the industrial structure and development stage of a country, the economic recession period could function as a perfect timing for the reduction in air pollution level and the mortality induced by pollution (Chen et al. 2016).

Particulate matter (PM) is a key indicator of air pollution brought into the air by a variety of natural and human activities.

Carbon dioxide is responsible to %58.8 of greenhouse gas emission that has adversely influences on health status, it is toxic to the heart and causes diminished contractile force. ( Muchopadhyay and Forssell, 2005, Davidson, 2003)

great in number scientific studies have explained particle exposure as the source of various health problems including premature death in people with lung disease and decreased lung function, irregular heartbeat, nonfatal heart attacks, aggravated pursiness, and increased respiratory symptoms such as coughing, irritation of the airways, or difficulty breathing (Atkinson et al. 2010; Cadelis et al. 2014; Correia et al. 2013; Fang et al. 2013; Meister et
2. Literature Review

Fang et al. (2013) estimated that about 5% of lung cancer deaths and 3% of cardiopulmonary arise due to particulate matter globally. Correia et al. (2013) suggested a possible relation between decrease in fine particulate matter and improved life expectancy based on data collected from 545 counties in the U.S. During the 2000-2007. Their studies represent that a decline of 10 μg m⁻³ of PM2.5 should have led to an increase of life expectancy by 0.35 years on average. Cao et al. (2011) perform a study to investigate the association between air pollution and mortality in 70,947 middle-aged men and women of the China National Hypertension Survey and its follow-up study.

Substantial associations were found between air pollution levels and mortality from lung cancer and cardiopulmonary diseases. Krewski (2009) indicate that Exposure to PM2.5 reduce the life expectancy of the population by about 8.6 months on average.

The similar research was estimated reflect the very significant role air pollution plays in cardiovascular illness and death. More and more, evidence demonstrating the linkages between ambient air pollution and the cardiovascular disease risk is becoming available, including studies from highly polluted areas.

3. Materials and Methodology

In this research an empirical model was used to examine the comparative effect of air pollution caused by greenhouse gases on the health indicators of Men and Women as below:

\[
LMR M_i = \alpha_i + \beta_1 LPM2.5_i + \beta_2 LCO2_i + \beta_3 OTG_i + \beta_4 SCM_i + U_i
\]

\[
LMRW_i = \alpha_i + \beta_1 LPM2.5_i + \beta_2 LCO2_i + \beta_3 OTG_i + \beta_4 SCW_i + U_i
\]

\(i = 1, 2, ..., N \) and \( t = 1, 2, ..., T \) denote number of countries \((i = 1, 2, ..., 33 (N))\) and time period \((t = 2000, 2001, ..., 2016 (T))\), respectively. \( \alpha \) are constants and \( \beta_1, \beta_2, \beta_3, \beta_4 \) are coefficients. \( U \) is the error term that are normally distributed with zero mean and homoscedastic variance \( U_{it} \sim d(0, \sigma^2 \epsilon) \). All the variables in Eq. (1, 2) are in logarithmic form. The main health status proxy variables in the both equations are Adult mortality rate men (MRM) and women (MRW), is the probability of dying between the ages of 15 and 60-that is, the probability of a 15-year-old men (women) dying before reaching age 60, if subject to age-specific mortality rates of the specified year between those ages.

There are three different air pollution proxy variables that their data are available for the analysis: 1. Carbon dioxide CO2 emissions (metric tons per capita) that are mostly stemming from the burning of fossil fuel and manufacture of cements that through releasing toxic substance into environment lead to negative health effects. 2. Particulate matter PM2.5 country level concentrations (micrograms per cubic meter). Particulate matter concentrations refer to fine suspended particulates less than 2.5 microns in diameter that are capable of penetrating deep into the respiratory tract and causing significant health damage. 3. Other greenhouse gas (HFC, PFC and SF6) emissions are by-product emissions of hydro fluoro carbons, per fluoro carbons, and sulfur hexafluoride (OTG).

In the both equations social factors such as education levels are represented for the estimation and school enrollment, tertiary (% gross), respectively. School enrollment, tertiary (% gross) of men in equation 1 (SCM) and women in equation 2 (SCW) are defined as total enrollment in tertiary educations, regardless of age, expressed as a percentage of population of official tertiary education age. It is seen that, levels of Gross enrollment ratio, significantly influence on CO2 emission and PM2.5 and other gas concentration of the countries (world Bank, 2016).

For this paper, data collected from 33 countries upper middle-income level in the period 2000-2016. This data obtained from World Bank and countries are Contains:

Albania, Algeria, Argentina, Azerbaijan, Belarus, Belize, Botswana, Brazil, Bulgaria, Colombia, Costa Rica, Croatia, Dominican Republic, Ecuador, Equatorial Guinea, Fiji, Guyana, Iran Islamic Rep, Jamaica, Kazakhstan, Lebanon, Macedonia, Malaysia, Mexico, Namibia, Panama, Paraguay, Peru, Romania, South Africa, Suriname, Thailand, Venezuela.

In this study we estimate the model by using panel data method. For using panel data model particular test method are used which will be discussed in this section. Before discussion about estimation and model analysis, it is necessary that why this study try to use the panel data method. In other words, are the countries -which are going
to be studied- homogeneous or not? If the countries are homogeneous Pool Data method can be easily used by ordinary least squares otherwise, the necessity of using panel data is required. In other words, based on statistical concept we have:

\[ Y_i = Z_i \delta + U_i \]  
Conditional Model

\[ Y_i = Z_i \delta_i + U_i \]  
Non-Conditional Model

\[ i = 1, 2, ..., N \]

The statistics for testing the hypothesis is as follows:

\[ F(N-1,NT-N-K) = \frac{(R^2 - R^2_{GLS})/(N-1)}{(1 - R^2_{GLS})/(NT-N-K)} \]

Where \( N \) represents the number of county, \( K \) the number of explanatory variables, \( T \) the number of observations over the time. In this test (which is called as significance effects of group test) when null hypothesis rejected, using of panel data is required. For decision about using of Fixed Effects method or Random Effects method, it must be considered that fixed effect method is usually used when total population is considered and if samples selected from big population, random effect method will be better method (Baltagi, 2005, 2008).

Hausman Test is used for determining the method of estimation in panel data approach which its statistic is (H) with \( \chi^2 \) distribution with \( K \) degree freedom (number of explanatory variables). If the null hypothesis rejected in the first test, the second test (Hausman Test) for the method of estimation in panel data methods will be used. In the Fixed Effects method, time aspect is not considered and only the effects which belong to each section of the time will be consider as individual effects. In the Random Effects method, time aspect is considered and the effects which belong to each section of the time will be consider as individual effects in the model. Hausman test statistic is as follows:

\[ H = \frac{\hat{\beta}_{FE} - \hat{\beta}_{RE(GLS)}}{\text{VAR}(\hat{\beta}_{FE}) - \text{VAR}(\hat{\beta}_{RE(GLS)})} \]

This test is hypothesis testing of uncorrelated individual effects and the explanatory variables which based on this test the generalized least squares estimation (GLS) under the \( H_0 \) hypothesis is consistent and under \( H_1 \) hypothesis is inconsistent. These hypothesis are as follows:

\[ H_0: E (u_i/x_i) = 0 \]
\[ H_1: E (u_i/x_i) \neq 0 \]

The rejection of the null hypothesis implies that the test method is fixed effects (Baltagi, 2005, 2008).

Table 1.

<table>
<thead>
<tr>
<th>Chow test results for men</th>
<th>Fixed Effect Test(Chow)</th>
<th>Significance level ( \times 10^{-4} )</th>
<th>F degree freedom</th>
<th>Calculated F</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Panel</td>
<td>(0.0000)</td>
<td>(29, 68)</td>
<td>209.24</td>
<td>( H_0 ) is rejected</td>
<td></td>
</tr>
</tbody>
</table>

Table 2.

<table>
<thead>
<tr>
<th>Hausman test for men</th>
<th>Hausman Test</th>
<th>Significance level ( \times 10^{-4} )</th>
<th>( \chi^2 ) degree freedom</th>
<th>Calculated ( \chi^2 )</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Test results for both model indicate that a good model is panel data model with fixed effects.

Model Estimation Results:

Table 3.

<table>
<thead>
<tr>
<th>variable</th>
<th>C</th>
<th>LPM2.5</th>
<th>LCO2</th>
<th>LOTG</th>
<th>LSCM</th>
<th>$R^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Method</td>
<td>Fixed Effects Model</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>6.56</td>
<td>0.036</td>
<td>0.07*</td>
<td>0.01</td>
<td>0.32</td>
<td>0.84</td>
</tr>
<tr>
<td></td>
<td>(0.000)</td>
<td>(0.48)</td>
<td>(0.09)</td>
<td>(0.000)</td>
<td>(0.000)</td>
<td>(0.000)</td>
</tr>
</tbody>
</table>

* indicates significance at 10%.

5. Conclusions and Discussion

Given the importance of health, this study aimed to investigate and compare the effects of air pollution from greenhouse gas emissions on the health of men and women in the upper middle-income countries including Iran.
Using panel data in the period 2000-2016, this study was conducted in which mortality rate of women and men was used as a health indicator. It was expected that as men stay longer outside and therefore are more exposed to air pollution it has a more damaging effect on their health, while the results showed that although greenhouse gas emissions significantly increase the mortality rate of women and men, its impact on women's mortality is more. Therefore, it can be said that environmental pollution, especially air pollution, will have a more negative effect on women due to their hormonal changes, regardless of skin, digestive, cardiovascular, pulmonary diseases and cancers.

Given the sensitivity of women, especially pregnant women, and the fact that air pollution will cause negative effects such as cardiac abnormalities, decreased IQ and fetal weight loss, and thus it will have negative consequences for the health of next generation; while the identification of health problems, including the effects of air pollution, should be prioritized, and fundamental measures should be taken to reduce pollutants, how to deal with this phenomenon should be taught especially to pregnant women and mothers and accurate information should be provided to them so that they refrain from going outside in urban open spaces on the days in which the air is polluted and consider fluids and foods including antioxidants and iron in their own diet. In addition, generally the identification and control of the sources of air pollution, urbanization control, the development of urban green space, the prevention of natural resource degradation, strict control and monitoring of the centers of technical inspection of vehicles, the development of public transport fleet, culture building and the development of equipment for measuring air pollutants can be effective in reducing air pollution and its harmful effects.

References


**Appendix**

Redundant Fixed Effects Tests

Equation: Untitled

Test cross-section fixed effects

<table>
<thead>
<tr>
<th>Effects Test</th>
<th>Statistic</th>
<th>d.f.</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cross-section F</td>
<td>209.244405</td>
<td>(29,68)</td>
<td>0.0000</td>
</tr>
<tr>
<td>Cross-section Chi-square</td>
<td>459.248364</td>
<td>29</td>
<td>0.0000</td>
</tr>
</tbody>
</table>

Correlated Random Effects - Hausman Test

Equation: Untitled

Test cross-section random effects

<table>
<thead>
<tr>
<th>Test Summary</th>
<th>Chi-Sq. Statistic</th>
<th>Chi-Sq. d.f.</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cross-section random</td>
<td>18.264224</td>
<td>4</td>
<td>0.0011</td>
</tr>
</tbody>
</table>

Dependent Variable: LMORT_M

Method: Panel Least Squares

Date: 07/01/18 Time: 11:25

Sample (adjusted): 2000 2012

Periods included: 5

Cross-sections included: 30
Total panel (unbalanced) observations: 102

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>t-Statistic</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>LPM2_5</td>
<td>0.036441</td>
<td>0.051753</td>
<td>0.704121</td>
<td>0.4838</td>
</tr>
<tr>
<td>LCO2</td>
<td>0.071167</td>
<td>0.041822</td>
<td>1.701677</td>
<td>0.0934</td>
</tr>
<tr>
<td>LOTHER_GAS</td>
<td>0.010897</td>
<td>0.001692</td>
<td>6.439972</td>
<td>0.0000</td>
</tr>
<tr>
<td>LSC_M</td>
<td>-0.319606</td>
<td>0.021913</td>
<td>-14.58496</td>
<td>0.0000</td>
</tr>
<tr>
<td>C</td>
<td>6.567690</td>
<td>0.183347</td>
<td>35.82110</td>
<td>0.0000</td>
</tr>
</tbody>
</table>

Effects Specification

R-squared 0.852498    Mean dependent var 5.219650
Adjusted R-squared 0.848857    S.D. dependent var 0.410668
S.E. of regression 0.043349    Akaike info criterion -3.177843
Sum squared resid 0.127784    Schwarz criterion -2.302852
Log likelihood 196.0700    Hannan-Quinn criter. -2.823529
F-statistic 272.6157    Durbin-Watson stat 0.996592
Prob(F-statistic) 0.000000

Dependent Variable: LMORT_F
Method: Panel Least Squares
Date: 07/01/18   Time: 10:53
Sample (adjusted): 2000 2012
Periods included: 5
Cross-sections included: 30
Total panel (unbalanced) observations: 102

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>t-Statistic</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>LPM2_5</td>
<td>0.003345</td>
<td>0.065160</td>
<td>0.051332</td>
<td>0.9592</td>
</tr>
<tr>
<td>LCO2</td>
<td>0.125363</td>
<td>0.051682</td>
<td>2.425674</td>
<td>0.0179</td>
</tr>
<tr>
<td>LOTHER_GAS</td>
<td>0.013620</td>
<td>0.002103</td>
<td>6.476425</td>
<td>0.0000</td>
</tr>
<tr>
<td>LSC_F</td>
<td>-0.284615</td>
<td>0.025463</td>
<td>-11.17772</td>
<td>0.0000</td>
</tr>
<tr>
<td>C</td>
<td>5.897152</td>
<td>0.234283</td>
<td>25.17103</td>
<td>0.0000</td>
</tr>
</tbody>
</table>
Cross-section fixed (dummy variables)

<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>R-squared</td>
<td>0.798824</td>
<td>Mean dependent var</td>
<td>4.607342</td>
</tr>
<tr>
<td>Adjusted R-squared</td>
<td>0.783400</td>
<td>S.D. dependent var</td>
<td>0.419554</td>
</tr>
<tr>
<td>S.E. of regression</td>
<td>0.054055</td>
<td>Akaike info criterion</td>
<td>-2.736416</td>
</tr>
<tr>
<td>Sum squared resid</td>
<td>0.198694</td>
<td>Schwarz criterion</td>
<td>-1.861425</td>
</tr>
<tr>
<td>Log likelihood</td>
<td>173.5572</td>
<td>Hannan-Quinn criter.</td>
<td>-2.382102</td>
</tr>
<tr>
<td>F-statistic</td>
<td>182.3159</td>
<td>Durbin-Watson stat</td>
<td>0.597123</td>
</tr>
<tr>
<td>Prob(F-statistic)</td>
<td>0.000000</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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