Atmospheric Pollution Research 7 (2016) 201–206

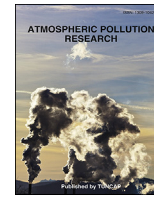
HOSTED BY

ELSEVIER

Contents lists available at ScienceDirect

Atmospheric Pollution Research

journal homepage: http://www.journals.elsevier.com/locate/apr



Original article

Health effects of air pollution: An empirical analysis for developing countries

Zahra Fotourehchi*

Department of Water Engineering, Faculty of Agricultural Technology and Natural Resources, University of Mohaghegh Ardabili, Ardabil, Iran

ARTICLE INFO

Article history:
Received 21 May 2015
Received in revised form
30 August 2015
Accepted 31 August 2015
Available online 14 October 2015

Keywords:
Infant mortality
Life expectancy
Air pollution
Recursive simultaneous equations model

ABSTRACT

In this research, we examine the effects of PM_{10} and CO_2 air pollutants on infant mortality and life expectancy at birth, in 60 developing countries during the period 1990–2010 by using unbalanced panel data and recursive simultaneous equations model. Our results show that the gains are obtained in the health status through the improvement in socio-economic conditions can be canceled by PM_{10} and CO_2 air pollutants. Therefore, health policies which just focus on socio-economic aspects and ignore the adverse impacts of the air pollution may do little in efforts directed to improve the current health status of developing countries.

1. Introduction

Developing countries are attempting to improve the health and life quality of the general population, but the associated rapid industrialization by increasing production scale has led to increase energy use and industrial waste, which has rendered worse air quality than developed countries. Furthermore, the processes of unplanned rapid urbanization, Pollution Haven Hypothesis and increasing population density have intensified both emission and concentration of air pollution in the considered countries. In fact, according to the Pollution Haven Hypothesis developing countries with cheap resource and labor tend to have less stringent environmental regulation and conversely, countries with stricter environmental regulations become more expensive for companies as a result of the cost associated with meeting these standards. Thus, companies that choose to physically invest in foreign countries tend to locate or relocate the pollution-intense industries to countries with lowest environmental standards (developing countries) or weakest enforcement.

Exposure to air pollution has deleterious effects on both physical and mental health. These effects can follow two routes: directly, through physical exposure that damages human health, or indirectly, through perception of risk and attendant chronic stress, both of these routes by means of increasing morbidity and mortality in cardiovascular (Pope and Dockery, 2006; Chen et al., 2008; Brook et al., 2010) and respiratory systems (Auerbach and Hernandez, 2012), lung development and function (Pope et al., 2002; Portnov et al., 2009), pregnancy outcome (Lin et al., 2001; Rogers and Dunlop, 2006), central nervous system (Block and Calderon-Garciduenas, 2009), etc. have detrimental effect on life expectancy at birth and positive effect on infant mortality. Especially, air pollutant such as PM_{10} which includes particles with an aerodynamic diameter of 10 mm or less. These particles are health concern as they are able to penetrate deep into the sensitive regions (thoracic or lower regions) of the respiratory tract (Quah and Boon, 2003). Furthermore, CO_2 is responsible to %58.8 of GHG emission (Bacon and Bhattacharya, 2007) has also adversely influences on health status (Mukhopadhyay and Forssell, 2005).

While there are a lot of studies (for example, Zhang et al., 2008) that look at the incidences of air or water pollution related-diseases or their effects on life expectancy and infant mortality at micro-dimension and in a particular country or region, to the best of our knowledge it has not been explored for different developing countries and various environment and health status indicators, simultaneously. Therefore, regarding the lack of macro studies in the literature, in this paper by focusing on negative effects of air pollutants such as PM_{10} and CO_2 on health status, we argue that the recorded health gains brought about by the improvement in socio-economic levels do not represent the total realizable health benefits. Without the appropriate environmental protection policies,

* Tel.: +98 9144529379; fax: +98 4533368323.
E-mail address: z.faturechi@yahoo.com.

Peer review under responsibility of Turkish National Committee for Air Pollution Research and Control.

http://dx.doi.org/10.1016/j.apr.2015.08.011

damages to a country's physical environment are incurred during the process of economic development. This negatively affects the health and well-being of individuals in the country and the aggregated impact could negate some of the health gains already derived, and hence dampen achievement levels in the health area. If we find that this argument has some empirical support (for example, Gangadharan and Valenzuela, 2001), it may imply that health policies addressing development issues are effectively also addressing the environmental issues.

The rest of the paper is organized as follows. Section 2 surveys the related literature on the relationship between air pollutants and health status. Section 3 describes the analytical framework and the estimation methodology used in the paper. Section 4 summarizes the data used in the analysis. Section 5 discusses the results from the estimation, and Section 6 concludes.

2. Related literature survey

There exists a large literature that has analyzed the relationship between different pollutants and health status, a number of previous studies in this literature have found statistically significant and positive relationship between various pollutants and infant mortality rate (see for example, Woodruff et al., 1997; Pereira et al., 1998; Abbey et al., 1999; Loomis et al., 1999; Gangadharan and Valenzuela, 2001; Chay and Greenstone, 2003; Mukhopadhyay and Forssell, 2005; Federman, 2010; Arceo-Gomez et al., 2012). Similarly, studies on different pollutants and life expectancy have shown that there is a negative relationship between the increases in pollutants and life expectancy (see for example, Nevalainen and Pekkanen, 1998; Coyle et al., 2011; Corria et al., 2013). In some of these studies negative effects of PM_{10} concentration (Pereira et al., 1998) and in some other, adverse effects of CO_2 emission (Mukhopadhyay and Forssell, 2005) have been concluded.

Most of these studies also control other factors that affect health status such as the accessibility of health services, income, health expenditure and education levels of the population.

Generally, in the previous studies that environmental degradation and health status have been indicated by different pollution and health proxy variables, detrimental health effects of air pollution have been confirmed. This major result can enforce that policy makers who do not choose environmental policies are not delivering the full realizable health gains that can be derived from higher socio-economic levels.

3. Analytical framework

3.1. Health production function and pollution

In the seminal work on the economics of health status, Grossman (1972) developed a household production function to model the demand for health. The health production function, as it relates to environmental health effects, is usually formulated as follows (Freeman, 2003):

$$H = h(d, b) \tag{1}$$

$$D = d(e, a) \tag{2}$$

$$H = h(e, a, b) \tag{3}$$

In Equation (1), H is health status, measured in different ways. While using survey data, H is best measured as the number of days off sick from work. If an aggregate health production function is estimated, then H is best measured as a mortality rate (Thornton, 2002, p.60). Health status (H) is a function of the level of pollution exposure or dose (d) and mitigating activities (b). A mitigating activity may consist of taking a medicine to relieve symptoms associated with exposure to a pollutant. Furthermore, in Equation (2), the dose of pollution (D) is a function of the concentration of a pollutant (e) and averting activities (a). An example of averting behavior is filtration of tap water for drinking purposes. By substituting Equation (2) into Equation (1), the health production function is obtained (Equation (3)), which varies with respect to concentration of the pollutant and the extent of averting and mitigating behavior.

Mitigating and averting behaviors (Equation (3)) are difficult to accurately measure. If a certain averting activity not only prevents pollution exposure, but also increases personal utility for other reasons, then it will be wrong to attribute all of the benefits of that activity toward valuation of pollution reduction. For example, the total cost of having an air conditioner in a car or home is not an accurate indicator of the cost of averting (or avoiding) air pollution exposure, because the air conditioner may also increase personal comfort (Freeman, 2003).

If the costs of mitigating and averting activities are not included in the health production function (this is always the case with aggregate data), then the estimated function becomes a dose–response function or a reduced form relationship between illness/mortality and pollution. As a consequence, the dose–response function (i.e. the cost-of-illness approach) only yields lower bound willingness to pay estimates for pollution reduction. Again, a dose–response model is the only option while dealing with aggregate data (e.g. geographic entities such as counties and states) where the implicit costs of pollution are not easily measured. In addition, in the estimation of the health production function it is crucial to control for physical and socioeconomic characteristics of individuals. These include age, sex, use of tobacco, income, education, etc. Without including mitigating and averting cost Equation (3) can be written:

$$H = h(e) \tag{4}$$

In this research to analyze health production function at macro level we define pollution level (e) as below:

$$E = e\,(y_1, z) \tag{5}$$

E is a function of level of economic development (y_1) and other determinant factors of pollution like as educational level (s), urbanization (u), population density (p) and globalization (g). By substituting Equation (5) into Equation (4), and controlling socioeconomic factors (v) that influence on health, the health production function (4) is obtained (Equation (6)):

$$H = h(e(y_1, z), v) \tag{6}$$

v includes, socio-economic factors like as economic development level (y_1), health expenditure (y_2), educational level (s) and life style (w). Empirically to analyze these issues, the following econometric model is formulated for country *i*:

$$e_{it} = \alpha_{i0} + \alpha_{i1} y_{1it} + \alpha_{i2} y_{1it}^2 + \alpha_{i4} z_{it} + u_{1it} \tag{7}$$

$$\ln(h_{it}) = \rho_i + \alpha_{i1}\ln(y_{1it}) + \alpha_{i2}\ln(y_{2it}) + \beta_i \ln(s_{it}) + \boldsymbol{\gamma_i}\, \mathbf{ln(e_{it})} + \delta_i \ln(w_{it}) + u_{2it}$$

where error terms (u_{it}) are normally distributed with zero mean and homoscedastic variance u_{it}~d (0, σ_ε^2). α_{i0}, ρ_i are constants and α_{i1}, α_{i2}, α_{i4}, β_i, γ_i, δ_i are coefficients.