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Valuing health effects of air pollution—Focus on concentration-response functions

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Abstract

The study investigates the morbidity impacts of air pollution when that pollution may affect both the likelihood and duration of respiratory problems. The relationship between comparatively low pollutant levels and respiratory ailments is estimated using Swedish data, and the change in respiratory restricted activity days (RRAD) due to a unit change in NO_2 is calculated. The analysis addresses overdispersion, the high proportion of zeros and the peak in the RRAD distribution. Our results highlight the challenge of setting air quality standards for environments where modest increases in pollutant concentrations may significantly prolong respiratory health problems for the most vulnerable individuals.

JEL classification: C24; I12; Q53

Keywords: Concentration-response; Air quality; Respiratory-related restricted activity days; Health

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1. Introduction

It has been estimated that about 3 million people die and many more suffer serious health effects each year because of air pollution (WHO [50]). When inhaled, air pollutants affect the lungs and respiratory tract but can also be absorbed and transported throughout the body by the blood stream, causing additional damage. The impact of pollution on health depends on levels of exposure and the susceptibility of the exposed population. However, it is difficult to distinguish air pollution from other factors affecting health.

The derivation of Concentration-Response Relationships (CRRs), often referred to as dose–response relationships, involves estimating physical or medical relationships linking both socio-economic and environmental variables, such as ambient concentrations of air pollution, to observable health effects. Health effects are divided into mortality impacts, where the primary endpoint is death, and morbidity impacts, where the endpoint is a non-fatal illness. Mortality effects are measured as changes in the probability of dying, and morbidity effects as changes in hospital admissions, symptom frequency, or labor productivity, such as work loss or restricted activity days.

The quantification of CRRs is crucial to evaluating the economic impacts of air pollution in terms of labor productivity. In recent contingent valuation studies on air pollution, the household production model has been applied to value morbidity impacts, e.g., Alberini et al. [1], Alberini and Krupnick [3], Navrud [32]. Our purpose is to augment the approaches in these analyses by showing the importance for valuation of appropriately estimating concentration response functions. In the spirit of Grossman [17], who first used the household production model to examine health decisions, we assume that health determines the total amount of time a person can spend producing monetary earnings and commodities and that both market and non-market time are relevant. Accordingly, productivity loss is easier to assess if, instead of using symptoms, one employs a measure of reduced labor productivity, e.g., the number of days a person is affected by the health impacts, as the health endpoint in the CRR when valuing the morbidity effects of air pollution.

Several studies (e.g., Ostro [36–39], Ostro and Rothschild [41], Hausman et al. [20]) have identified CRRs for US data, using restricted activity days or work loss days as a measure of the health impact of pollution. That this work is still cited in the literature (e.g. Hansen and Selte [18], Holland et al. [21], Ostro and Chestnut [40], and Zuidema and Nentjes [52]) indicates that more recent research serving comparative purposes is lacking. Be this as it may, one must bear in mind that the data in these studies, collected in the 1970s and 1980s, are now dated, and the estimation methods used can be considered unsuitable in many respects. Yet, the results of the earlier studies have been recently used for estimating productivity loss and assessing health impacts from pollution for other regions. For example, a recent research project of the European Commission, ExternE, used US studies to evaluate the external costs of different fuel cycles in European countries (see JOULE [25]). Other studies using results from US CRRs in Europe are Markandya and Pavan [29], who assessed health effects from air pollution for four European countries, and Bellander et al. [5], who linked exposure data to hospital admissions for Stockholm.

The short-term effects of air pollution on mortality and hospital admissions were studied in a research project including 12 European countries (APHEIS [4], Katsouyanni [26]), but the health endpoints used did not capture less severe morbidity effects. In two recent