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Analysis

Do people habituate to air pollution? Evidence from international life satisfaction data

Tobias Menz *

Department of Economics, University of Oldenburg, 26111 Oldenburg, Germany

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ABSTRACT

Air pollution constitutes one of the main environmental problems in many countries. This paper uses the life satisfaction approach to environmental valuation (LSA) to investigate whether individuals habituate to air pollution and if a potential habituation effect influences the marginal rate of substitution between air quality and income. My estimation results, based on a data set of 48 countries spanning the period 1990 to 2006, indicate that individuals do not habituate to pollution with particulate matter. Rather, I find that even past pollution levels reduce current utility. This effect tends to increase the value of pollution abatement.

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1. Introduction

Air pollution with particulate matter (PM10) constitutes one of the main environmental problems in many countries. Short- and long-term exposures to this pollutant lead to increased human morbidity and mortality rates (see WHO, 2005). Furthermore, high levels of particulate matter are responsible for reduced crop yields, urban haze, and increased erosion of building materials (see Int Panis et al., 2004; Tidblad and Kucera, 2001).

In the light of this, governments worldwide started to implement clean air policies over the last decades. Ideally, such policies should be preceded by cost-benefit analyses in which monetary values are assigned to air quality. Given that air quality is a public good and has no market price, effective and efficient environmental policies critically depend on information provided by environmental economists, who have developed different valuation techniques to calculate the value of clean air. In addition to more common valuation techniques such as contingent valuation, hedonic pricing, or impact pathway studies, the life satisfaction approach to environmental valuation (LSA) is a novel method for calculating the shadow price of air quality or other public goods and bads (see Welsch, 2002; van Praag and Baarsma, 2005, or Rehdanz and Maddison, 2005 for early applications). Using this approach, Levinson (2009), Ferreira and Moro (2010), and Menz and Welsch (2010) found that reducing PM10 concentrations by 1 μg per cubic meter is worth 136 to 1000 USD per capita.[1] Though the variance of these results is quite high, they are largely in accord with values from more common valuation techniques.[2]

This paper uses LSA to investigate whether past pollution with particulate matter impacts the valuation of air quality. This analysis is important since most environmental valuation studies only consider the value of current air quality (see Section 2). Yet, the concentration on current air quality might be misleading given that epidemiological literature suggests health-related impairments of pollution with particulate matter manifest rather gradually (see Schwartz, 2011). Ignoring this might lead to underestimated values of air quality improvements. Otherwise, people might habituate to air pollution to some extent.[3] In this case, studies that ignore past pollution levels might overestimate the (long-term) value of clean air.

[1] The respective values are given in USD 2005. To get a sense of the size of these values, note that average PM10 concentrations in 2006 were 23 μg per m^3 in OECD countries and 77 μg per m^3 in non-OECD countries (see WDI 2009).

[2] See Section 2 for an overview of typical values for the absence of pollution with PM10.

[3] Levinson (2009) and MacKerron and Mourato (2009) speculated that habituation effects could be relevant to air pollution but did not investigate this question empirically. Section 2 offers more explanations on habituation to air pollution.

* Tel.: +49 441 798 4105; fax: +49 441 798 4116.
E-mail address: tobias.menz@uni-oldenburg.de.

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This paper's empirical analysis is based on an unbalanced data set of 48 countries spanning the period 1990 to 2006. I regress national life satisfaction on current and lagged GDP per capita as well as current and lagged PM10 concentrations to examine whether lagged PM10 affects life satisfaction negatively (due to the gradual occurrence of health effects) or positively (due to adaptation). I find that past pollution levels significantly reduce current life satisfaction. That is, the gradual occurrence of PM10-related diseases outweighs possible habituation effects. Pertaining to the valuation of clean air, my findings suggest that controlling for the effects of past pollution raises the value of clean air by a factor of roughly 2.5.

This study contributes to the literature by showing that the explicit inclusion of past pollution levels in an environmental valuation study significantly increases the value of clean air. Furthermore, it can be seen as an important robustness test for previous LSA studies dealing with PM10. These studies only considered data from industrialized countries. This paper includes data from non-industrialized countries and also takes into account the non-stationarity of some variables to avoid spurious regressions.

The paper is structured as follows: Section 2 discusses the previous literature on the monetary valuation of air quality, with a special focus on the LSA. Also, health impacts related to pollution with particulate matter and possible habituation effects to air pollution are discussed. In Section 3, the applied methodological framework, the hypotheses, and the data are presented. Section 4 discusses the estimation results. The paper concludes with a short summary and a description of limitations in Section 5.

2. Previous Literature and Methodology

2.1. Consequences of PM10 Pollution and Their Monetary Valuation

The adverse consequences of particulate matter pollution are manifold. First, it has a serious impact on building materials. The effects include loss of mechanical strength, leakage, and failure of protective coatings due to degradation of materials (see Tidblad and Kucera, 2001). Second, regional atmospheric haze depresses crop yield for wheat, barley, potato, and other species (see Int Panis et al., 2004). Third and foremost, high concentrations of this pollutant cause an increase in human morbidity and mortality rates. Short-term exposures at elevated concentrations are connected with an exacerbation of pre-existing respiratory diseases and symptoms as well as increased hospital admissions for respiratory and cardiac ailments (Katsouyanni et al., 2011). Long-term exposures can cause diseases such as chronic bronchitis or lung cancer (Schwartz, 2011). That is, some of these impairments become obvious directly after exposure, whereas others become manifest with a significant time lag (see Katsouyanni et al., 2011; Schwartz, 2011).

Several studies have analyzed the monetary valuation of PM10. These studies used contingent valuation methods (Alberini and Krupnick, 1998), hedonic valuation approaches (Bayer et al., 2009; Chattopadhyay, 1999; Smith and Huang, 1995), impact-pathway-methods (Wattkis et al., 2005), or LSA (Ferreira and Moro, 2010; Levinson, 2009; Menz and Welsch, 2010).[4] Table 1 offers an overview of their study-setups and their main findings pertaining to the valuation of PM10.

Table 1
Valuation of PM10 – evidence from other studies.

	Valuation method	Data set	Value of a reduction in PM10 concentrations by 1 μg per cubic meter (converted in USD 2005)
Smith and Huang (1995)	Meta study on hedonic studies	Several U.S. cities (1967–1988)	109–348
Alberini and Krupnick (1998)	Contingent valuation	900 individuals in urban Taiwan (1991/1992)	25–32
Chattopadhyay (1999)	Hedonic study	Chicago (1990)	361–491
Wattkis et al. (2005)	Impact pathway study	Several European countries	339–694
Bayer et al. (2009)	Hedonic study	U.S. metropolitan areas (1990–2000)	239–297
Levinson (2009)	LSA	6052 U.S. citizens (1994–1996)	883
Ferreira and Moro (2010)	LSA	1500 Irish citizens (2001)	921
Menz and Welsch (2010)	LSA	25 OECD countries (1990–2004)	117–199

The results from the more common valuation studies are in the range of 25 to 694 USD per microgram PM10. The values from Levinson's (2009) and Ferreira and Moro's (2010) life satisfaction studies are somewhat higher, whereas the life satisfaction study from Menz and Welsch (2010) generates values inside this range.[5] That is, the LSA has proven helpful in generating monetary values that are comparable to other environmental valuation studies. None of these studies explicitly considered the effect of past particle pollution on the valuation of PM10. Thus, as explained in the Introduction, these studies eventually under- or overestimate the value of clean air. As will be explained below, LSA is especially well-suited to studying the effects of both current and past air pollution. Therefore, this paper uses LSA to investigate whether past pollution with PM10 affects the valuation of clean air.

2.2. The Life Satisfaction Approach to Environmental Valuation

Life satisfaction data are included in national and international surveys (e.g., German Socio Economic Panel, British Household Panel Survey, Eurobarometer, or World Value Survey) together with other socio-demographic data such as income, age, residence, marital status, or job market status. In the respective polls, questions like, "How satisfied are you with your life?" are included. The respondent can choose among different alternatives ranging from "not at all satisfied" to "very satisfied." Although these data are ordinal, many researchers transformed them into cardinal values, ranging, for instance, from 1 = not at all satisfied to 4 = very satisfied.[6]

The use of life satisfaction data in economic studies requires the fulfillment of two assumptions (see also Frey et al., 2010 or Welsch and

[4] LSA will be explained in more detail below. I will briefly outline the basic ideas of the other valuation techniques. In contingent valuation studies, individuals are directly asked their willingness to pay for air quality contingent on different hypothetical scenarios. Hedonic valuation studies examine house and labor markets to analyze how house prices and wages depend on differences in local air quality. Impact pathway studies use bottom-up approaches that follow the pathway from source emissions via quality changes of air, soil, and water to physical impacts, before being expressed in monetary benefits and costs. Please refer to Wattkis et al. (2005), Welsch and Kühling (2009), or Frey et al. (2010) for further explanations of these methods as well as their respective advantages and disadvantages.

[5] In contrast to Levinson (2009) and Ferreira and Moro (2010), Menz and Welsch (2010) account for hedonic adaptation to income. Thus, (current) income has a higher marginal utility in their study which leads to lower monetary values of air quality. Further information on adaptation to income is offered in Section 2.3.

[6] Pertaining to this transformation, Kahneman (1999) argued that assuming cardinality on the ordinal scale of satisfaction categories might be a theoretical problem, but less a practical one. Additionally, different researchers (e.g., Ferrer-i-Carbonell and Frijters, 2004) provide evidence that assuming cardinality or ordinality of life satisfaction data has almost no effect on empirical results. Note that ordered probit or ordered logit models can be used to analyze ordinal data, whereas linear regression models are well suited for the analysis of cardinal data. Welsch and Kühling (2009) provide an overview of the methodologies used by previous life satisfaction studies.

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