Methodological and Ideological Options

Measuring environmental inequality

James K. Boyce [a],*, Klara Zwickl [b], Michael Ash [c]

[a] Political Economy Research Institute and Department of Economics, University of Massachusetts Amherst, United States
[b] Institute for Ecological Economics, Department of Socioeconomics, Vienna University of Economics and Business, Austria
[c] Department of Economics and Center for Public Policy and Administration, University of Massachusetts Amherst, United States

ABSTRACT

This study presents alternative measures of environmental inequality in the 50 U.S. states for exposure to industrial air pollution. We examine three methodological issues. First, to what extent are environmental inequality measures sensitive to spatial scale and population weighting? Second, how do sensitivities to different segments of the overall distribution affect rankings by these measures? Third, how do vertical and horizontal (inter-group) inequality measures relate to each other? We find substantive differences in rankings by different measures and conclude that no single indicator is sufficient for addressing the entire range of equity concerns that are relevant to environmental policy; instead multiple measures are needed.

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1. Introduction

Pollution is a public bad – the opposite of a public good – but its burdens are not shared equally across the public. In the United States, a large body of research has documented the disproportionate environmental burdens faced by racial and ethnic minorities and low-income households (see, for example, Szasz and Meuser, 1997; Ash and Fetter, 2004; Mohai, 2008; Bullard et al., 2011). These and other disparities are important features of many environmental landscapes.

In examining environmental inequalities, a number of studies have applied inequality measures that were originally developed to measure the distribution of income and wealth. Many of these have focused on international inequalities, including inter-country disparities in carbon emissions (Heil and Wodon, 2000; Duro, 2012) and resource use (Druckman and Jackson, 2008). With the exception of one study in the state of Maine (Bouvier, 2014), however, inequality measures have not been applied to the distribution of industrial air pollution exposure within the U.S.

In this study we present several different inequality measures for industrial air pollution exposure in the U.S. states and compare the resulting inter-state rankings. The extent of pollution exposure disparities between racial and ethnic groups and income classes has been found to vary considerably across U.S. regions (Zwickl et al., 2014) and metropolitan areas (Downey, 2007). Here we conduct our analysis at the state level, intermediate between larger regions and smaller metropolitan areas. Inter-state comparisons are of interest because states vary both in the strength of their environmental regulations and in the extent to which their environmental policies incorporate explicit distributional objectives (Bonorris, 2010).

Using data on exposure to industrial air toxics from the Risk-Screening Environmental Indicators (RSEI) database of the U.S. Environmental Protection Agency (EPA), we compute several measures of inequality to consider three important questions:

• First, to what extent are measures of environmental inequality sensitive towards the spatial scale and population weights? Previous studies have emphasized the importance of fine spatial disaggregation to avoid the so-called "ecological fallacy" — erroneous inferences about smaller geographical units or individuals drawn from data on larger aggregates (Ash and Fetter, 2004). We apply a well-known measure of inequality – the Gini coefficient – to air pollution exposure and compare measures based on 810 m^2 grid cells to those based on

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* Corresponding author.
E-mail addresses: boyce@econs.umass.edu (J.K. Boyce), klara.zwickl@wu.ac.at (K. Zwickl), mash@econs.umass.edu (M. Ash).

(generally larger) census tracts to examine whether these alternative units of observation yield substantially different results. In addition, we examine the effect of weighting these spatial units by their population.

- Second, how do the sensitivities of inequality measures to different ranges of the distribution affect inter-state rankings? In the case of industrial air pollution, exposures often are concentrated at the top of the distribution: many households are exposed to relatively low levels, while a small percentage is exposed to very high levels. Researchers and policy makers may be particularly interested in measures that are more sensitive to differences within the upper range of the distribution.

- Third, how do inter-state rankings based on vertical inequality compare to rankings based on horizontal inequality? Vertical measures of inequality differentiate the population solely by the variable of interest (here, pollution exposure), whereas horizontal measures partition the population on the basis of other characteristics. Here we consider pollution exposure differences by minority status and income, criteria in the environmental justice policies of federal and state agencies.

Section 2 reviews motivations for measuring environmental inequality — why the distribution of environmental harm may matter as well as its overall magnitude. Section 3 discusses the data used in our analysis. Section 4 explains the methods used to calculate alternative measures of exposure inequality, and Section 5 presents the results of applying these to industrial air pollution exposure in the 50 states. Section 6 concludes with a discussion of the policy implications of our findings and potential avenues for further research on environmental inequality.

2. Welfare Effects of Environmental Inequality

As scholars of income and wealth distribution have pointed out, the choice of inequality measures is not only a technical question but also depends on underlying notions of social welfare (Atkinson, 1970). Before discussing alternative measures, therefore, it is useful to consider the welfare implications of environmental inequality.

The distribution of environmental quality matters for social welfare for at least three reasons. The first is *intrinsic*, founded on the normative principle that every person has an equal right to a clean and safe environment. The second is instrumental: environmental quality can have important impacts on *opportunities* to lead a healthy and productive life, and equality of opportunities is widely accepted as a normative goal. The third, also instrumental, is that environmental quality can have important impacts on *economic outcomes* for individuals and communities, the distribution of which has been the primary concern of economists who study inequality. This section discusses these rationales with a focus on air pollution, which is characterized by the World Health Organization (2014) as "the world's largest single environmental health risk."

2.1. Intrinsic Value of Environmental Equity

The normative principle that every person has the right to a clean and safe environment has been widely affirmed in recent decades in the most fundamental of legal documents, national constitutions. The post-apartheid Constitution of the Republic of South Africa, for example, states: "Every person shall have the right to an environment which is not detrimental to his or her health or well-being." The Constitution of Argentina similarly affirms, "All residents enjoy the right to a healthy, balanced environment." The Constitution of Chile guarantees to all persons "the right to live in an environment free from contamination." The Constitution of Portugal provides, "Everyone shall have the right to a

healthy and ecologically balanced human environment and the duty to defend it."[1]

The U.S. Constitution does not explicitly guarantee the right to a clean and safe environment, but implicit endorsement of this principle is "already contained in the thousands of pages of federal environmental statutes and regulations now on the books" (Meltz, 1999). The Clean Air Act, for example, directs the EPA to promulgate and enforce ambient air quality standards, "the attainment and maintenance of which … are requisite to protect the public health."[2] Explicit affirmations of the right to a clean and safe environment were added to a number of U.S. state constitutions starting in the 1970s. The Massachusetts Constitution states, "The people shall have the right to clean air and water." The Hawaii Constitution provides, "Each person has the right to a clean and healthful environment, as defined by laws relating to environmental quality, including control of pollution and conservation, protection and enhancement of natural resources." The Illinois Constitution affirms, "Each person has the right to a healthful environment." The Pennsylvania Constitution specifies, "The people have a right to clean air, pure water, and to the preservation of the natural, scenic, historic and esthetic values of the environment." The Montana Constitution states, in language that evokes the U.S. Declaration of Independence, "All persons are born free and have certain inalienable rights. They include the right to a healthful environment…".

By asserting the normative principle that all persons have a right to a clean environment, these provisions place an intrinsic value on the distribution of environmental quality. Regardless of how the practical matter of translating this goal into policies is handled – including the question of how clean the environment must be in order to qualify as "clean" – this principle implies that the environmental rights of some should not take precedence over the environmental rights of others.

Presidential Executive Order 12898, issued by Bill Clinton in 1994, directs each U.S. government agency to take steps to identify and rectify "disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations," explicitly inscribing equity across groups defined on the basis of race, ethnicity and economic status into federal environmental policy. Many states have also adopted environmental justice policies (Bonorris, 2010). In a proclamation marking the 20th anniversary of the executive order on environmental justice, President Barack Obama reaffirmed "every American's right to breathe freely, drink clean water, and live on uncontaminated land" (Obama, 2014).

2.2. Equality of Opportunity

A second motivation for concern about environmental inequality is its impact on equality of opportunity, which is widely accepted as a normative goal. "Much more important than inequality of outcomes among adults is inequality of opportunity among children," write the authors of the World Bank's Human Opportunity Index, noting that "the idea of giving people equal opportunity early in life, whatever their socioeconomic background, is embraced across the political spectrum" (Barros et al., 2009, p. xvii).

Children are especially vulnerable to the health impacts of pollution, and environmental quality can significantly affect a child's life chances (Currie, 2011). The impacts extend to the odds of survival. For example, a study of the impact of reduced air pollution in the U.S. during the 1981–82 recession found that for each one percent decrease in total suspended particulates, infant mortality declined by 0.35% (Chay and Greenstone, 2003). Emissions controls implemented by the state of California are estimated to have prevented approximately 1000 infant deaths from carbon monoxide exposure in the 1990s (Currie and Neidell, 2005).

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[1] Similar statements appear in the Constitutions of many other nations. For examples and discussion, see Popovic (1996).
[2] 42 U.S. Code §7409 — National primary and secondary ambient air quality standards.