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Analysis

Distribution of income and toxic emissions in Maine, United States: Inequality in two dimensions

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ABSTRACT

Ecological distribution refers to inequalities in the use of environmental sinks and sources. This article explores one such dimension of ecological distribution — that of toxic air emissions. Using data from the Risk-Screening Environmental Indicators model and the United States Census Bureau, I analyze the distribution of both environmental risk and income at the block-group level in the state of Maine. The state of Maine was chosen for its historical dependence upon natural resources as well as its economic and spatial heterogeneity. Results clearly indicate that the toxic air emissions are distributed much more unequally than is income, and that those inequalities are reinforcing. While not in itself an indication of environmental injustice, such analyses may help us to rethink the assumption that there is a tradeoff between income and pollution.

1. Introduction

Sustainability is sometimes said to have three “pillars”: economic prosperity, environmental protection, and social equity (General Assembly of the United Nations, 2013). Indeed, the concept of “just sustainability” focuses on four conditions: “improving our quality of life and well-being; on meeting the needs of both present and future generations (intra- and intergenerational equity); on justice and equity in terms of recognition, process, procedure and outcome and on the need for us to live within ecosystem limits” (Agyeman, 2012). Yet despite the seeming emphasis on equity, the most common indices of sustainability include only the distribution of monetary income (or of consumption), not the distribution of environmental quality or well-being. In addition, most such indices include income inequality as a stand-alone concept — in other words, income inequality is not integrated directly in the overall index (European Statistical Library, n.d.; Fordham Institute for Innovation in Social Policy, 2004; Messinger and Coleman, 1998; U.S. Interagency Working Group on Sustainable Development Indicators, 1998), or, at best, discount GDP according to some measure of income inequality (see, for example, Friends of the Earth, n.d.; Hamilton and Saddler, 1997).

Even the consideration of the degree of a society's level of income inequality in indices of sustainability implicitly acknowledges that income inequality is indeed an important concern. However, the distribution of other components of well-being is also crucial. One such distribution is what ecological economist Joan Martinez-Alier calls ecological distribution: the “social, spatial, and temporal asymmetries or inequalities in the use by humans of environmental resources and services, i.e., in the depletion of natural resources (including the loss of biodiversity), and in the burdens of pollution” (Martinez-Alier, 1995, p. 520). Especially in countries where subsets of the population depend greatly on natural resources for their livelihood, then inequalities in the use of resources or the depletion of resources has a direct link to inequality of well-being. A link between inequalities in the burden of pollution and inequality of well-being is less direct, but no less real.

In this article, I will explore one dimension of ecological distribution — the distribution of air pollution. Sudhir Anand argues, in his article “The Concern for Equity in Health” (Anand, 2002), that a person's health holds a special status, as it has both an instrumental value and an intrinsic value: “Health is regarded to be critical because it directly affects a person's wellbeing and is a prerequisite to her functioning as an agent. Inequalities in health are thus closely tied to inequalities in the most basic freedoms and opportunities that people can enjoy” (p. 485). A similar argument could be made for inequalities in pollution.

Pollution, in its many forms, is directly related to an individual's well-being. That fact may be self-evident, as in the polluting of drinking water in Delhi (Lalchanandi, 2013) or the visible smog in China (Staff, 2013), but it also may be more subtle — and, in fact, could affect our well-being in ways of which we are unaware. We are only just beginning, for example, to tease out the links between gene expression and certain pollutants (Steingraber, 2010). Furthermore, the level and type of pollution a person is exposed to could affect that person's ability to

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function both in the economic sphere ("black lung," for example, having prematurely shortened the working lives of many miners in Appalachia and around the world) and in the leisure sphere (asthma affecting a person's ability to participate in sports).

Consequently, inequality in the burden of pollution can be a "double whammy:" pollution does not only affect a person's well-being directly, but also could affect that individual's earning potential, leading to inequality in the realm of income as well. Finally, there is the added complication that productive activity *causes* pollution, implying that while we may be able to reduce pollution inequality, we risk doing so at the expense of decreasing economic growth.

It is important here to make a distinction between *inequality* and *inequity*. Levy et al. (2006) capture the distinction thus: "Equality is … characterized by homogeneity or sameness among individuals or social groups. It is often depicted as uniformity in rights or experiences despite differences in resources, capabilities and backgrounds …. In contrast, the concept of inequity identifies the subset of inequalities that are deemed unjust and unfair by a socially-derived calculus" (p. 3). The authors then provide examples of the distinction: "For example, health inequalities stemming from genetic differences or freely chosen health damaging behavior would *not* be considered inequitable; variations resulting from unknown exposure to unhealthy working conditions or limited social mobility *would* be categorized as inequitable" (p. 3, emphasis mine). While the distribution of income or pollution may be unequal, such inequality is not, by itself, evidence of an inequity.

Various hypotheses have been advanced to help explain the direction and the strength of the relationship between one's income and the quality of the environment in which they live (the environmental justice hypothesis that low-income people tend to live in more polluted areas than the wealthy is one example). Such a relationship may not be one-dimensional, however. For some individuals, inequality in the distribution of income may be reinforced by inequality in pollution, such that those individuals would be disadvantaged both in income and in pollution. For other individuals, the inequalities may be offsetting: whereas an individual may command a low income, they may be advantaged by having cleaner air or a more pristine environment.

This article investigates such a question. I develop a two dimensional index of inequality which allows for us to empirically investigate the question of whether inequality in pollution and inequality in income are reinforcing or countervailing. I then use that index to investigate the distribution (both spatial and demographic) of toxic air pollution in the state of Maine. I focus on the state of Maine for a variety of reasons. First, the small state allows for more careful, detailed analysis than might be the case with whole country-wide analyses or even larger states. More importantly, the state of Maine in some ways can be seen as a microcosm of other parts of the world. Maine has for many years been referred to as "two Maines" — the more populous and urbanized southern section of Maine, and the less economically prosperous and more remote regions of northern Maine (Charles, 1994). While Maine as a whole has been historically dependent on natural resources, southern Maine's economy is now more diverse, whereas much of northern Maine's economy remains disproportionally dependent upon these products. Therefore, Maine offers a convenient case study through which to examine the spatial and economic distribution of pollution and income.

I establish a spatial Gini coefficient for toxic air emissions in the state of Maine, using data from the U. S. Census Bureau and the U.S. Environmental Protection Agency's Risk-Screening Environmental Indicators (RSEI) model. Furthermore, I develop an index of environmentally-adjusted income and calculate the resulting Gini coefficient, thus measuring the inequality in the co-distribution of income and pollution. Results indicate that pollution (in the form of toxic emissions) is distributed much more unequally than the distribution of income. Moreover, a substantial segment of Maine's population is disadvantaged in two dimensions: they experience a lower than average income but a higher than average emission level.

The structure of the remainder of the article is as follows. Section 2 reviews the literature on the distribution of pollution or other measures of risk. Section 3 describes the data and methodology. Section 4 describes the results. Section 5 concludes.

2. Literature Review

2.1. "Distribution Hypotheses" and the Relationship Between Income, Pollution, and Inequality

There are several competing and well-known hypotheses about the relationship between pollution and income at the local level that can be explored using concepts of ecological distribution. The first may be termed the "trade-off hypothesis." In this view of the world, an individual is confronted with various employment and residential locations, all of which vary in terms of their job opportunities and other amenities, including their pollution level. An individual desiring to live in an area with a lower pollution level would theoretically "trade off" a certain amount of her income in order to do so. An individual who is not able or willing to pay that price would then live in the more polluted area with the higher wage. Individuals would sort themselves according to their preference for environmental quality (Cropper and Arriaga-Salinas, 1980). Under such a hypothesis, we would expect inequalities in income and in pollution to be subtractive, rather than additive, as we might expect individuals living in cleaner areas to command less income, and individuals living in more polluted areas to have higher incomes.

The theory of compensating wage differentials just described has its roots in Rosen (Rosen, 1979). Rosen developed a theoretical model demonstrating that an individual living in a low amenity area may, in theory, be compensated for the lack of amenities with a higher income. Although Rosen's theory has been tested for numerous amenities, studies of compensating wage differentials for pollution specifically have been few and far between. Bayless (1982) analyzed the salaries of university professors and concentrations of total suspended particulates (TSP). He found that a one standard deviation increase in TSP was associated with a compensating wage variation of between 1 and 2%. Roback (1982) likewise demonstrates that there is indeed an "implicit price" associated with living in a polluted area — average annual earnings were significantly higher in an area with higher particulate matter (ceteris paribus). More recently, Cole et al. (2009) find that there is a "positive and significant wage premium attached to working in a dirty industry, across a range of pollution exposure measures" (p. 162).

A second hypothesis, which also works through the market but with the opposite result, might be called the market hypothesis. Under this idea, individuals who have a higher level of income might afford to live in a more pristine or unpolluted location, whereas an individual who had lower willingness (or ability) to pay for a location with lower pollution levels would end up in the more polluted locales. Hanna (2007) conducted a hedonic analysis of wages and housing values on emissions. She claims:

> There are also good reasons to expect that pollution levels are influenced by neighborhood incomes. If the willingness to pay for a clean environment is increasing in income, income groups will be sorted into residential locations according to pollution levels, with the rich living in cleaner areas, ceteris paribus (Hanna, 2007, pp. 102–103).

Hanna finds a statistically significant and negative estimate of the relationship between pollution and *non-wage* income, "consistent with an endogenous sorting of income groups by pollution levels" (p. 111) (Contrary to the trade-off hypothesis, however, she finds no evidence that pollution has an influence upon wage and salary incomes). Income sorting such as this would result in wealthy people living in less polluted areas, whereas poorer people would live in more polluted regions. Inequalities in income and pollution would thus be additive. Although