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Looking through a different lens: Examining the inequality-mortality association in U.S. counties using spatial panel models

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ABSTRACT

Two areas still need further examination in the ecological study of inequality and mortality. First, the evidence for the relationship between income inequality and mortality remains inconclusive, particularly when the analytic unit is small (e.g., county in the U.S.). Second, most previous studies are cross-sectional and are unable to address the recent diverging patterns whereby mortality has decreased and income inequality increased. This study aims to contribute to both topic areas by studying the relationship between inequality and mortality via a spatiotemporal approach that simultaneously considers the spatial structure and the temporal trends of inequality and mortality using county panel data between 1990 and 2010 for the conterminous U.S. Using both spatial panel random effect and spatial panel fixed effect models, we found that (a) income inequality was not a significant factor for mortality after taking into account the spatiotemporal structure and the most salient factors for mortality (e.g., socioeconomic status); (b) the spatial panel fixed effect model indicated that income inequality was negatively associated with mortality over the time, a relationship mirroring the diverging patterns; and (c) the significant spatial and temporal fixed effects suggested that both dimensions are critical factors in understanding the inequality-mortality relationship in the U.S. Our findings lend support to the argument that income inequality does not affect mortality and suggest that the cross-sectional findings may be a consequence of ignoring the temporal trends.

1. Introduction

One unsettled debate in mortality research is whether or not income inequality (hereafter, inequality) positively affects mortality in the United States (U.S.) (Deaton, 2003; Kawachi & Blakely, 2001; Lynch, Smith, Harper, & Hillemeier, 2004; Lynch, Smith, Harper, Hillemeier, et al., 2004; Mellor & Milyo, 2001). Several county-level studies provide evidence supporting the positive inequality-mortality relationship (Cossman, Cossman, Cosby, & Reavis, 2008; McLaughlin, Stokes, & Nonoyama, 2001; McLaughlin, Stokes, Smith, & Nonoyama, 2007; Yang, Chen, Shoff, & Matthews, 2012); however, some scholars argued that the association between inequality and mortality is spurious (Deaton & Lubotsky, 2003; Laporte, 2002; Mellor & Milyo, 2001; Muller, 2002) or is negatively related (Deaton & Paxson, 2001) due to both methodological shortcomings (e.g., endogeneity), and substantive weaknesses (e.g., the underexplored mediation mechanisms through which inequality affects mortality).

The mixed findings have led researchers to examine the inequality-mortality relationship with more rigorous analytic methods. As inequality and mortality are both aggregate measures, it is suggested that the potential dependency among analytic units should be controlled (Matthews & Parker, 2013). Several studies used spatial econometrics methods to control for spatial dependency with findings supporting the inequality-mortality relationship (Sparks & Sparks, 2010; Yang & Jensen, 2014). Despite this research, the extant literature on ecological mortality research lacks a longitudinal perspective. This study is motivated to fill these gaps.

Why is a longitudinal perspective important? The answer to this question is two-fold. From a substantive viewpoint, should the claim that inequality affects mortality in the cross-sectional research stand, one would expect that the fluctuations in

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mortality are reflected in the fluctuations in inequality. That is, if inequality increases/decreases, mortality should increase/decrease accordingly or at least show a pattern reflecting latency over time. However, the U.S. mortality and inequality trends in the past few decades have diverged. On the one hand, the U.S. mortality has declined from roughly 11 deaths per 1000 population in 1980 to 7.5 deaths per 1000 population in 2010 (Hoyert, 2012). The downward trend holds for both crude and age-adjusted death rates. On the other hand, over the same time period, income inequality has increased remarkably (Piketty & Saez, 2004). Using a range of adjusted Gini indices, one study (Burkhauser, Feng, Jenkins, & Larrimore, 2011) reported that income inequality has been trending upward since the 1970s, with a significant increase observed around 1990.[1] Though the inequality trend seems to have slowed down in recent years, the overall upward trend is evident. From a longitudinal perspective, the two opposite trends would seem to suggest that income inequality and mortality are either unrelated or negatively related, which challenges the common belief that inequality is bad for mortality (*c.f.* Deaton and Paxson, 2001; Clough-Gorr, Egger, & Spoerri, 2015).

From a methodological standpoint, the cross-sectional analysis fails to take into account the temporal correlations and/or time-persistence of unobserved factors within the same unit, which introduces bias to coefficient estimations (Baltagi, Song, & Koh, 2003; Baltagi, Song, Jung, & Koh, 2007). Mellor and Milyo (2001), for example, used time series analyses to argue that the inequality-mortality relationship at the aggregate level does not hold as the intra-unit variation in inequality in cross-sectional analyses could undermine the relationship between inequality and mortality. While several economists have proposed new space-time analysis frameworks (Anselin, Le Gallo, & Jayet, 2008; Elhorst, 2014; Lee & Yu, 2010), the availability of user-friendly programs has been limited (Millo & Piras, 2012) and as such few studies have adopted a space-time approach to explore the association between inequality and mortality.

There are two negative consequences when space and time are ignored. First, the intra-county dynamics across time cannot be captured, which may bias the estimate of the inequality-mortality relationship. Specifically, a cross-sectional design fails to consider serial correlation bias (i.e., the temporally correlation) within a county. Second, without spatiotemporal analysis the spatial relationships between analytic units cannot be used to explain why spatial patterns in mortality perpetuate over time.

This study is motivated by the observed divergence of mortality and inequality trends, the methodological significance, and the potential consequences of ignoring space and time. The aims are to answer the following related questions as they pertain to a study of U.S. counties and explore whether/how inequality and mortality are related after considering the spatiotemporal structure: (1) Does inequality remain a significant factor for mortality after considering the spatiotemporal structure and other fundamental mortality covariates? (2) If the answer to the first question is yes, does income inequality positively affect mortality or does their relationship mirror the diverging trend? And (3) what is the role of the spatiotemporal structure in understanding the inequality-mortality relationship?

The remainder of this paper is organized as follows: we begin with a review of the literature on mortality and inequality and discuss whether inequality matters. Next we describe the methods and data, followed by the presentation of findings. We close with a discussion section.

[1] While these trends are nationwide, they are confirmed with county-level descriptive statistics reported in this study.

2. Literature review

2.1. Why does/should inequality matter?

Before discussing why inequality matters, it is important to acknowledge that the inequality and mortality levels in the U.S. are higher than those in other developed countries. More specifically, income inequality (as measured by the Gini coefficient) in the U.S., a liberal welfare state (Esping-Andersen, 2002), ranged from 0.40 to almost 0.5 between 1990 and 2010; however, over the same time span, other welfare state countries (e.g., Netherland and Nordic countries) had a Gini coefficient varying between 0.25 and 0.30 (The World Bank, 2016). Coupled with the higher mortality rates, the inequality-mortality relationship in the U.S. has been a unique phenomenon among developed countries.

As mortality is a commonly used health indicator to assess population health, the theoretical arguments as to why inequality matters in mortality research are largely built upon the association between inequality and health. The first theoretical linkage between inequality and mortality is drawn from the relative deprivation literature. That is, within a given area, the unequal distribution of wealth creates a sense of relative deprivation, which may in turn become psychosocial stressors that eventually undermine health (Marmot, 2004; Wilkinson, 2006). This *psychosocial pathway* has been used to explain why inequality is a factor for mortality among developed countries. Specifically, unlike the poor in developing countries, the impoverished population in developed countries may still have access to electricity, water, adequate housing and other durables. If only the absolute standard of living mattered, income inequality should not matter in developed countries. As Wilkinson (2006) pointed out, the sense of relative deprivation helps us understand the relationship of inequality with health. This perspective has received support from a range of studies. For example, several scholars (Kawachi, Levine, Miller, Lasch, & Amick, 1994; Wilkinson, 1997; Wilkinson & Pickett, 2009) have found that living in an area with a high level of inequality leads to stress, frustration, depression, anxiety, among other mental illnesses. These psychosocial discomforts could make individuals engage in risk behaviors, such as smoking, binge drinking, drug use, and antisocial behaviors, and consequently hinder individual health and increase the risk of death. It should be noted that this relative deprivation argument can also be applied to individuals near the top rungs of the social hierarchy (Lynch & Kaplan, 1997).

The other bridge between inequality and health suggests that high income inequality can create unequal distributions of resources and underinvestment in physical, cultural, and civic infrastructures (Daly, Duncan, Kaplan, & Lynch, 1998; Kawachi, Kennedy, Lochner, & Prothrow-Stith, 1997; Lynch, Smith, Harper, & Hillemeier, 2004; Lynch, Smith, Harper, Hillemeier, et al., 2004; Lynch & Kaplan, 1997). Kaplan, Pamuk, Lynch, Cohen, and Balfour (1996) analyzed the data from the 50 U.S. states and found that higher levels of income inequality were associated with lower educational expenditure per capita, fewer investments in library resources, lower levels of health insurance coverage, higher exposure to crimes, and higher rates of incarceration. Their findings support the argument that high inequality may limit one's life chances (e.g., access to public services and resources) and are more likely to lead to an environment with poor infrastructure and social conditions. As Link and Phelan (1995) suggested, these social conditions are the fundamental causes of diseases and have substantial impacts on health. Thus, high income inequality may be associated with high mortality through an *underinvestment pathway*. The underinvestment and psychosocial pathway are interrelated: investment in social programs or infrastructures redistributes wealth and the provision of public services may minimize the sense of relative