Industrial Structure and Poverty in the US Upper Midwest, 1960-2010:
New Evidence on Spatial-Temporal Regimes

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Abstract
Poverty in the US is unevenly distributed. Places with high poverty rates tend to neighbor other places reporting high poverty and, for the most part, high poverty counties have been impoverished for decades. A wealth of research identifies industrial structure as a central correlate of poverty, suggesting that the spatial distribution and temporal dynamics of industry are reflected in the spatial patterning and temporal trends in poverty. However, few studies have investigated both dimensions simultaneously, thereby leaving a central tenet of theory on poverty and place unexamined. We apply advanced spatial statistical models to investigate whether there are predictable patterns of spatial variation and temporal changes in the relationship between industry and poverty. Preliminary results show less spatial variation in the relationship between industry and poverty over time, and that temporal variation in the relationship generally is consistent across space, supporting and offering nuance to a core hypothesis of theory on poverty and place.

Extended Abstract

Introduction
Poverty in the United States is unevenly distributed across spatial and temporal dimensions. Places with high rates of poverty tend to neighbor other places reporting high poverty rates (Glasmeier 2006). Moreover, high poverty counties, for the most part, have been impoverished for decades (Beale and Gibbs 2006). A wealth of research identifies industrial structure as a central correlate of poverty at the aggregate level (i.e., county) (Brady and Wallace 2001; Friedman and Lichter 1998, see also Voss et al. 2006; Green and Sanchez 2007; Kodras 1997; Lichter and McLaughlin 1995; Lobao and Schulman 1991; Tickamyer and Tickamyer 1988; Weinberg 1987), suggesting that the spatial distribution and temporal dynamics of industry are reflected in the spatial patterning and temporal trends in poverty. However, few large-scale studies of spatial inequality have explicitly investigated both dimensions simultaneously, thereby leaving a central tenet of theory on poverty and place unexamined.

Recent research has used advanced statistics to begin to address the interconnectedness of space and time in generating, perpetuating and, possibly, changing poverty (Curtis et al. 2012; Chokie and Partridge 2008; Jha 2000). However, it has not investigated the ways in which space and time interact to affect the relationships between county poverty and its presumed drivers. That is, research generally has adopted an analytical approach that quantifies an average association that presumably applies equally to all places and/or in all periods. This strategy is problematic given that research demonstrates and theory asserts variation between places and across periods.

In our study, we apply advanced spatial statistical models to dynamically link spatial variation and temporal changes in industrial structure to county-level poverty. We draw on the economic restructuring and spatial inequality literatures to inform our hypotheses on the spatially- and temporally-varying relationship between poverty and industrial structure. Specifically, we investigate whether there is predictable spatial variation in the relationship between industrial structure and poverty, and whether the relative strength of the relationship changes over time in a predictable direction.

Data and Methods
We examine census panel data for the US Upper Midwest between 1960 and 2010 drawn from decennial censuses and the 2006-10 American Community Survey 5-year Estimates. The study region and period provide an ideal site for our research given the region's significant industrial restructuring and diversity since the mid-20th century. We examine all counties within the states of Illinois, Indiana, Iowa, Michigan, Minnesota, and Wisconsin.

We adopt an analytical approach akin to a "regime" analysis while simultaneously accounting for underlying spatial autocorrelation. Space and time are treated as endogenous effects through a spatial error regression and, concurrently, as exogenous effects through a regime approach. By incorporating both endogenous and exogenous effects, we address both heterogeneity and dependence processes. In our study, we are primarily concerned with the heterogeneity process (identifying the relationship between industry and poverty) net of any underlying dependence process (likely an artifact of the spatial-temporal panel data structure). We use a second-order contiguity spatial weights matrix to isolate the endogenous effects.

The regression model can be represented as $y_{i,t} = \beta_0 + \beta_1 x_{1,i,t} + \beta_2 x_{2,i,t} + ... + \beta_p x_{p,i,t} + \varepsilon_{i,t}$, where the response variable is $y_{i,t}$ at time t, site i; the explanatory variables are $x_{1,i,t}$, $x_{2,i,t}$, ..., $x_{p,i,t}$; with interpretable

1

Curtis et al.

regression coefficients β_0, β_1, β_2, …, β_p; and an error process $\varepsilon_{i,t}$. We regress county poverty on industry, regime, and an interaction between industry and regime, where the regime corresponds with the state or the year. This strategy is used to test (1) whether there is spatial variation in the relationship between industrial structure and poverty throughout the period and (2) whether the relative strength of the association between industrial structure and poverty changes over time.

Preliminary Results
Our preliminary analysis of manufacturing, the service sector, and agriculture in the Upper Midwest between 1960 and 2010 shows evidence of more spatial variation in the relationship between industry and poverty in the early decades of the study period and comparatively less spatial variation in the later decades. This finding suggests the effect of industry differs across states, although to a decreasing extent over the period. Wisconsin and Michigan are distinct in their patterns from other states in the Upper Midwest, especially in the earlier periods. For example, in 1970 manufacturing had a significantly higher protective effect against poverty in Wisconsin and Michigan as compared to Indiana and Iowa (Table 1). However, there is no difference in the relationship between manufacturing and poverty in the 2006-10 period between these states. Instead, manufacturing was uniformly associated with poverty among counties in the Upper Midwestern states.

Preliminary results also show evidence of changes over time in the direction of the relationship between the particular industries and poverty. For example, manufacturing is negatively associated with poverty in the earlier decades, but positively associated in the latest decade (Table 2). While once associated with lower poverty rates, manufacturing was associated with higher poverty rates by the 2000s. The service sector shows a similar temporal pattern, one shifting from protective to promoting poverty. Combined, preliminary results show less spatial variation in the relationship between industry and poverty over time, and that temporal variation in the relationship generally is consistent across space.

Citations

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Curtis et al.

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Table 1. Excerpt from a spatial regime (state) analysis of poverty and manufacturing in the Upper Midwest

States	Manufacturing	
	1970	**2006-10**
Indiana vs Michigan	-1.10 -3.37	ns
Indiana vs Michigan	-1.10 -4.05	ns
Iowa vs Michigan	-0.69 -3.37	ns
Iowa vs Wisconsin	-0.69 -4.05	ns

Curtis et al.

Table 2. Excerpt from a temporal regime (year) analysis of poverty and manufacturing in the Upper Midwest

State	Manufacturing	
Michigan		
2006-10 vs 1970	5.43	-3.37
2006-10 vs 1980	5.43	-3.89
2006-10 vs 1990	5.43	-4.88
2006-10 vs 2000	5.43	-2.04
Wisconsin		
2006-10 vs 1970	4.16	-4.05
2006-10 vs 1980	4.16	-5.20
2006-10 vs 1990	4.16	-8.20
2006-10 vs 2000	4.16	-5.01

Curtis et al.