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Poverty, Place, and Coal Employment across Appalachia and the United States in a New Economic Era*

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ABSTRACT The impacts of employment in the coal industry remain controversial. Few studies have investigated these impacts over the decade of the great recession and in light of the nation's changing energy economy. We bring together two long-standing rural sociological traditions to address debates framed at the national level and for Appalachian communities facing the throes of transition from the coal industry. Building from rural sociology's "poverty and place" tradition and from natural resources sociology, we examine the relationship between coal employment and communities' economic well-being as indicated by poverty, household income, and unemployment. The study spans U.S. and Appalachian counties from 1990 to 2010. U.S. counties with greater coal employment in 1990 had lower income and higher poverty in 2000. Overall, however, coal employment's effect is mixed in the 1990–2000 decade. By contrast, for the recent 2000–2010 decade, coal employment is positively associated with indicators of well-being. In Appalachia, fewer employment alternatives outside mining are related to higher well-being. Our findings extend the poverty and place literature and the natural resources literature and underscore why a just transition away from coal should focus on moving communities toward sectors offering better future livelihoods.

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Introduction

Dramatic transformations in the energy industry are unfolding across the United States, raising public and scholarly debate about the impacts on communities. While new shale gas and oil development receive increased rural sociological attention, the coal industry is undergoing a serious transition (Bell and York 2010). Historical boom-bust cycles for coal have been accompanied by a protracted decline in its employment nationally and particularly in Appalachia. Long-term employment decline stems particularly from technological change as the industry became more capital intensive (Wasson, Kay, and Foley 2013). The momentous new Environmental Protection Agency regulations championed by President Barack Obama to reduce pollution from coal-fired power plants are expected to usher in future declines with the magnitude hotly debated (Banks et al. 2015; Davenport 2014; Gabriel 2014). Coal mining jobs are higher paying and more unionized than other jobs in the region. Contemporary shifts coincide with an anemic labor market and broadening economic climate of lower wage, nonunion, more precarious employment (Kalleberg 2011; Kristal 2013). A socially just transition from coal will require better sociological understanding of how this sector affects communities over time and relative to existing labor market alternatives.

In this study, we take a new look at employment in the coal industry prior to and across the great recession decade as other forms of energy development are in ascendance. Our objective is to investigate the extent to which coal employment is related to communities' economic well-being. Using a new series of data, our study has the advantage of spanning the contiguous United States, but we also focus on Appalachia with its historical dependence on coal mining and high poverty (Billings and Blee 2000; Ziliak 2012) and greater vulnerability to future coal employment decline (Betz et al. 2015; Gabriel 2014). This study offers a unique view in terms of period (1990–2010), national geographic coverage, and ability to compare coal mining with oil and gas mining and other sectors.

Our focus on coal employment and communities' economic well-being is important for rural sociology for several reasons. First, rural sociologists have a legacy of concern with the impacts of extractive industries on communities' well-being as seen in numerous studies discussed below. Second, although the coal industry is experiencing a serious transition, few recent sociological studies scrutinize the impacts of coal employment. Past research usually treats mining as a homogeneous extractive industry. Moreover, rural sociology's most concerted effort to

understand how employment in extractive industries affects communities' economic well-being is now decades old (i.e., Rural Sociological Society Task Force on Persistent Poverty 1993). Third, existing research on coal employment tends to be case studies or region and state specific. Few generalizable studies exist in part because researchers have lacked detailed employment data and needed to rely on secondary sources that aggregate all mining.[1] Although analyzing mining as a single sector may have been less critical in the past, today the different development paths of coal and of oil and natural gas call for a more nuanced approach. Most significantly, rural sociologists have produced conceptual literatures that can inform national debates about employment in coal mining. It is timely to draw from this foundational work.

Conceptually, our study seeks to better bridge and advance two long-standing rural sociological traditions, the "poverty and place" literature and research from natural resources sociology. Although both traditions address sociological concerns about spatial inequality, they have developed rather independently (Lobao 2004). The poverty and place literature is our starting point. It addresses a range of employment sectors and economic well-being indicators along with national labor market processes. Natural resources sociology emphasizes the dynamics of extractive-sector production and resource-dependent communities. Scrutinizing coal mining employment advances these two traditions in an era of rapid transformation in the energy industry.

The coal mining industry can be analyzed in different ways, beyond assessing it as an employment sector. Coal mining's negative effects on the environment, including climate change, and workers' health are well established (Tallichet 2014). Our research is limited to coal employment and economic well-being as indicated by poverty, income levels, and unemployment, a concern derived from both the poverty and place literature and natural resources sociology. Our central analytical question is whether levels of coal employment as well as growth and decline in this employment affect subsequent economic well-being. The next section summarizes recent debates around this question. Then we turn to our two conceptual literatures to develop a synthetic account of coal employment's influence.

[1] Most empirical studies were conducted prior to 2000. Nord and Luloff (1993), focusing on the 1970s and 1980s, provide one of the few rural sociological examinations of the coal industry across the nation.

Debates about Coal Mining Employment: The Nation and Appalachia

This study responds to debates framed at both the national and regional scale. For nations as a whole, social scientists continue to question the influence of mining on economic well-being. Cross-national development theories such as dependency and world system theory associate a larger extractive sector with poorer economic well-being (for a recent update see Bonini 2012). Theory from economics puts forth a similar view that hypothesizes a natural resource curse across nations (Deller and Schreiber 2012). However, Bonini (2012) argues that the long-assumed negative relationship between the extractive sector and well-being needs to be revisited. She explains that more positive relationships can arise where nations nurture their extractive sectors as integrated engines of development and capture economic gains internally. Deller and Schreiber (2012) report that few studies have applied the natural resource curse hypothesis subnationally to the case of the United States and that findings are mixed as to whether localities with a larger extractive sector have poorer economic well-being. In a meta-analysis of mining studies conducted from the 1970s to the 1990s, Freudenburg and Wilson (2002) found that about half report negative community impacts, while the remainder split between positive and no impacts. Finally, with regard to coal mining employment itself, Krugman (2014) taking issue with antienvironmental, proindustry projections about new EPA regulations, suggests minuscule if any discernable effects: "coal mining accounts for only one-sixteenth of 1 percent of overall U.S. employment: shutting down the whole industry would eliminate fewer jobs than America lost in an average week during the Great Recession of 2007–2008."

Although the nation may not experience profound impacts from coal mining employment, affected regions may. Rural sociologists have long observed that the costs of natural resource transitions are not borne equally. Rural people often experience greater livelihood setbacks (Rural Sociological Task Force 1993). Recently in response to climate change policy, a "political economy of a just transition" has emerged that stresses the importance of assessing how poorer people and regions will be affected by the national movement to cleaner energy (Newell and Mulvaney 2013).

Changes in the coal industry particularly affect Appalachia. With the Clean Air Act of 1990, demand for low-sulfur coal rose, which contributed to redistributing coal production to western states. Nationally, Appalachia's share of coal production was 43 percent in 1997, falling to 28 percent in 2012. At the same time, western states' share rose from 41

percent to 53 percent (U.S. Energy Information Agency 2014). Gross U.S. coal production itself fell 7 percent over this period but Appalachian coal production fell by 37 percent. Meanwhile boom-bust periods have occurred, with the 1990s generally an era of decline and 2000–2010 more of a boom period (Betz et al. 2015; Partridge, Betz, and Lobao 2013). These changes along with the legacy of poverty in Appalachia indicate continued path-dependent vulnerability to the fortunes of the coal industry (Ziliak 2012).

Beyond the social sciences, the relationship between coal mining employment and economic well-being remains at the core of public debates. Freudenberg (2006) stresses that polluting industries engage in distraction, seeking to steer public opinion toward jobs and income growth over environmental concerns. Bell and York (2010) explain that prioritizing jobs and income tends to resonate with the Appalachian public. But does coal mining even lead to any sustained improvement in jobs and income? Weighing in on the debate, Woods and Gordon (2011) found no evidence that mountaintop extraction creates local jobs. We extend this debate by analyzing the influence of coal mining employment on three indicators: poverty, household income, and unemployment.

Conceptualizing the Impact of Coal Mining on Communities

To conceptualize coal employment's relationship to well-being, we bring rural sociology's poverty and place literature into greater dialogue with natural resources sociology. The conceptual foundation underlying our study and both literatures is economic sociology's structural approach to employment sectors. In brief, the structural approach stresses that the quality and quantity of employment produced by capitalists varies in different stages of development and in turn results in variations in workers' earnings and family incomes (Dwyer 2013; Hodson 1983; Kalleberg 2011). In the poverty and place literature, rural sociologists extend the structural approach spatially to analyze how variations in employment by industry sector affect economic well-being across U.S. communities (Lobao 2004; McLaughlin and Coleman-Jensen 2008; Peters 2012). In the natural resource literature, the quality and quantity of employment generated by extractive industries is conceptualized as an underlying determinant of community well-being (Freudenberg and Wilson 2002). We see both literatures as complementary and as filling gaps within each other with regard to the analysis of the mining industry.

The Poverty and Place Tradition: Mining and Communities across the United States

Our conceptual starting point is the poverty and place literature, a tradition that broadly addresses spatial inequality at the subnational scale. Here wide-ranging studies analyze well-being across U.S. communities. Rural sociologists contribute centrally to this literature; for reviews see Brown and Schaftt (2011) and Lobao (2004). This literature also spans geography (Glasmeier 2002), economics (Partridge and Rickman 2006; Weber et al. 2005), and regional science (Isserman, Feser, and Warren 2007). In the poverty and place tradition, scholars share a thematic interest in the determinants of communities' economic well-being and focus on indicators such as poverty rates, income levels and inequality, job growth, and unemployment. Scholars commonly examine three sets of determinants of well-being: economic structure or the quantity and quality of local employment sectors; demographic factors such as age, education, ethnicity, and family structure that reflect residents' human capital and structural vulnerability; and rural-urban location and other geographic attributes. Economic well-being is usually hypothesized to be higher in places with a greater share of higher quality employment sectors (Cotter 2002; Moller, Alderson, and Nielsen 2009) and a smaller share of vulnerable populations (such as populations with higher educational attainments and smaller minority populations) (Lichter and Cimbaluk 2012; Voss et al. 2006). Places located closer to metropolitan centers are usually hypothesized to have higher economic well-being (Mencken 1997; Partridge and Rickman 2006). In quantitative studies, researchers examine these determinants across the United States using county, city, or other aggregate-level secondary data.

As our interest is in employment by industry sector we explain briefly how employment sectors are conceptualized. Researchers often draw from economic sociology's industrial segmentation literature which defines sectors by quality and quantity of employment as noted above (Hodson 1983; Kalleberg 2011; Kristal 2013). Higher wage industries, such as manufacturing (in the past) and finance, insurance, and real estate services, are usually contrasted with lower wage service industries. Industrial sectors are assumed to influence communities' economic well-being in direct and indirect ways (Blank 2005; Bloomquist and Summers 1982). Primary impacts occur through earnings and occupational structures that affect workers' household income and future labor market opportunities. Secondary impacts occur through economic multiplier effects as goods and services are purchased from

other sectors. For example, Black, McKinnish, and Sanders (2005) found multiplier effects for Appalachian communities, reporting that every 100 new jobs in coal add 25 new indirect jobs. With higher wage employment, wage spreads may occur across other sectors in a community as labor costs are driven up when employers compete in the labor market. Thus, at any cross-sectional time point, researchers tend to find that communities with greater higher wage employment fare better: incomes are higher and poverty is lower (Blank 2005; Rupasingha and Goetz 2007; Weber et al. 2005).

Few studies compare mining to other sectors in assessing community well-being (see Deaton and Niman 2012). In sociology's economic-segmentation literature, mining is treated as falling into the "core sector" of higher quality jobs where earnings and unionization tend to be higher (Bloomquist and Summers 1982; Hodson 1983). However, both mining and manufacturing are prone to greater layoffs than services. Postrecession, mining is classified as remaining in the high-wage sector (with median hourly wages above $20) while most manufacturing has now fallen to midwage (NELP 2014).

The few national studies of mining with rare exceptions (e.g., Betz et al. 2015; Nord and Luloff 1993) combine all types. These studies tend to report positive or mixed impacts of mining on community well-being. Isserman et al. (2007) find that more prosperous rural counties had a greater share of mining employment over the 1990s. Slack and Jensen (2004) in a study spanning 1974–98 found that mining is related to lower underemployment and its beneficial effect is greater than that for manufacturing. Holzer et al. (2011) showed that growth in mining employment is positively linked to metropolitan areas' earnings growth, highlighting impacts in urban areas. Deller and Schreiber (2012) found that mining is related to higher per capita income growth for nonmetro counties from 2000 to 2007. However, mining had no effect on employment growth and a negative effect on population growth, suggesting that mining may depress future well-being if populations avoid such communities. In a recent national analysis Betz et al. (2105) found that coal mining employment has a mixed effect on economic development indicators. The most consistent effect is that coal mining is related to lower growth in proprietors' employment, which suggests that coal mining may stifle local entrepreneurship.

In sum, studies from the poverty and place tradition span communities across the United States and a range of industrial sectors. When mining is analyzed, its effects appear to be mixed rather than entirely deleterious.

Mining from the Lens of Natural Resources Sociology

Natural-resource-based industries' relationship to community well-being also receives interdisciplinary attention. Rural sociologists' contributions to this literature are well documented by review articles (England and Brown 2003; Freudenburg 2006; Rural Sociological Task Force 1993; Stedman 2013). While this tradition overlaps with poverty and place research, differences exist. In addition to giving foremost attention to the extractive sector, natural resources research tends to center on a limited number of communities rather than spanning the nation. There is also less interest in comparing across economic sectors and general labor market processes. However, even in the natural resource tradition few studies explicitly examine coal mining employment.

The uniqueness of extractive industries is often analyzed through a focus on natural-resource-dependent communities. This focus differs from our interest in *levels of mining employment across a range of U.S. communities*. Nevertheless, this literature informs our study by detailing the processes by which mining may affect economic well-being.

The distinct features of extractive industries are summarized by England and Brown (2003). These industries tend to be embedded in global markets controlled by nonlocal firms. They manifest a history of exploitative relationships, distinct phases of development, and susceptibility to boom-and-bust shocks. Freudenburg's (1992) classic research explains specific processes that jeopardize community well-being. He notes that communities tend to become "addicted" or overadapt to extractive industries, with busts becoming particularly devastating. Extractive communities are prone to developing overly specialized economies in which future diversification is difficult to achieve. "Flickering" or periodic shutdowns tend to increase unemployment (Freudenberg and Wilson 2002). To economists, the concept of the "natural resource curse" distinguishes similar processes whereby communities lag over the long term due to lack of alternative labor market opportunities, volatility in commodity prices, and underinvestment in education (Partridge et al. 2013). Finally, the general process of path dependence is relevant for understanding both natural resource extraction and agriculture (Gasteyer and Carrera 2013; Stedman, Partiquin, and Parkins 2012). These sectors may give rise to self-reinforcing development paths that displace other industries, leading to less sustainable and less diverse local economies. Extending these points provides a rationale for expecting negative community impacts over the long run where mining employment is higher than in other areas.

Yet, when turning to empirical studies of the extractive sector or mining, researchers note variations in impact along distinct lines. Freudenburg and Wilson (2002) document systematic variations in the impacts of mining using a meta-analysis based on 301 findings from 19 studies, most conducted prior to the mid-1990s. First, impacts vary somewhat by indicator. More positive impacts tend to be found for local income levels while more adverse impacts tend to be found for local unemployment. For extractive industries more generally, Stedman (2013) reports similar variations. Relatively high wages in mining are more likely to have direct positive outcomes for local income levels but the propensity for layoffs may increase unemployment. Second, findings vary by region: southern states appear to fare worse and western states better (Freudenburg and Wilson 2002; Nord and Luloff 1993; Stedman et al. 2012). Finally, periods with price upswings tend to usher in more positive impacts (Freudenburg and Wilson 2002).

Place, Poverty, and Coal Jobs: The United States and Appalachia

Taken jointly, the poverty and place literature and natural resources sociology offer important insights into debates about coal mining. The first tradition conceptualizes economic structure and exogenous community attributes and identifies methodological issues in studying impacts. Surprisingly, although the energy sector is undergoing dramatic transition as an engine of national development, few studies in this tradition have analyzed mining. Natural resources sociology stresses the importance of mining, yet much evidence about its effects is dated and from limited numbers of communities.

Both traditions would be advanced by updating to the post–Great Recession era and by more detailed treatment of mining. First, as national economic sectors undergo transformation, long-standing relationships with community well-being may shift. As coal mining has become more capital intensive and higher wage, it may contribute to higher community incomes and lower poverty particularly if displaced workers leave. Within the mining sector, high-wage support activities such as prospecting, surveying, and mapping have tended to grow relatively as production becomes more intensive (Freudenburg and Gramling 1994). Second, other employment sectors that in the past produced community resiliency may no longer do so, thereby increasing mining's importance. For example, places that had greater manufacturing in the past now tend to be more likely to experience higher poverty (Lichter and Cimbaluk 2012; Moretti 2012). Third, recent shifts in energy production are producing new rounds of uneven development. Much of

Appalachia has not shared in the boom over the last decade from growth in oil and gas production (U.S. Census Bureau 2013).

Finally, broader shifts have reduced Americans' well-being and created greater dependence on the market. Analysts note that in recent decades, livelihoods are more precarious, a trend seen in escalating consumer debt, stubborn unemployment, and growth in lower wage jobs (Harvey 2005). For less-educated workers especially, good job opportunities have declined (Holzer et al. 2011:51). Migration rates have also slowed, with populations stuck in place and more dependent on local communities for jobs (Partridge et al. 2012). In 2006 median hourly earnings in coal mining were $19.33, compared to $14.61 for all U.S. industries (U.S. Department of Labor, Bureau of Labor Statistics 2006).[2] Unionization rates in 2006 were at 19 percent for workers in coal and other nongas and nonoil mining compared to 12 percent for all private industries (SourceWatch 2014). In this new economic climate, mining may have more positive impacts relative to other sectors including manufacturing.

For Appalachia, recent work suggests that some past negative outcomes of mining may be waning. Lichter and Cimbaluk (2012) found that extractive-sector employment was not a significant determinant of poverty for Appalachian counties over the 1990–2009 period. Partridge et al. (2013) found that coal mining employment related to higher poverty across Appalachian counties in the 1990s but no significant relationship for the post-2000 years. Reporting positive impacts of mining, Slack and Jensen (2004) indicate that factors such as low education and distance from urban areas may have contributed to detrimental impacts found in earlier studies. Nevertheless, persistent concerns remain about mining and local economic well-being. Capital-intensive production and layoffs are structural features of the industry that contribute to reducing mining jobs. Over the long term, local businesses in other sectors may be crowded out as larger coal companies compete for local labor and as industries such as tourism are discouraged by environmental damages and air and water pollution (Woods and Gordon 2011). These processes from coal-related path-dependent development may continue to influence Appalachia. Analyzing Appalachia in two periods allows us to examine whether the region today retains its often assumed negative outcomes from the coal industry.

[2] Some examples of earnings in other sectors are: manufacturing ($15.64), care-related services (education, health, and social) ($16.55), and food and accommodation services ($8.00) (U.S. Department of Labor, Bureau of Labor Statistics 2006).

Summary and Research Questions

Our central analytical question is to what extent does employment in coal mining influence economic well-being across communities? We extend two foundational rural sociological literatures to respond to this question. The poverty and place tradition recognizes that economic sectors, including mining, may influence well-being across U.S. communities. In terms of the direction of relationships, the limited research on mining from this tradition suggests that its influence is mixed. Mining employment is more likely to have a more positive influence now relative to the past, particularly when compared to sectors such as manufacturing whose benefits for workers have declined relative to the past (Moretti 2012). Natural resources sociology has generally pointed to long-term negative outcomes from mining across resource-dependent areas. However, researchers caution that variations exist and that mining has better outcomes in boom periods.

We analyze the influence of coal mining across place and time. By scrutinizing the United States, we respond to national debates about coal mining noted earlier and to rural sociology's poverty and place tradition that has little analysis of mining employment. Here we question the influence of coal mining employment nationally and relative to other sectors, particularly manufacturing, which in the past offered stable, higher quality employment (Cherlin 2014). By scrutinizing Appalachia, we respond to regional debates about coal mining and to natural resources sociology's interest in historically resource dependent communities. Here we focus on a region where coal employment should particularly influence economic well-being outcomes. We also question the impact of mining over two distinct periods: 1990–2000, a relatively robust economic era when poverty declined across the nation, particularly in rural areas (Partridge and Rickman 2006); and the 2000–2010 decade that spans the "dot-com" 2001 recession and the Great Recession years. Coal prices were lower in the former decade and higher in the latter (U.S. Energy Information Agency 2012). These trends suggest that coal mining employment should be more negatively related to well-being in 1990–2000 owing to low prices and to national prosperity generating better opportunities across other sectors.

Data and Methods

We follow quantitative poverty and place studies in selecting counties as units of analysis, control variables, and models that address spatial dependence in relationships. Advantages of counties include general stability in boundaries, usefulness in capturing labor-market processes,

and data availability (Partridge and Rickman 2006). We examine counties across the contiguous United States and the Appalachian Regional Commission's (ARC) 420 counties in 13 states. We perform analyses for the two different decades discussed above, 1990–2000 and 2000–2010. This study requires detailed mining data that span small, rural counties for single time points—thus we use a unique series of data.

Dependent Variables

We use as dependent variables three indicators of economic well-being: the total population poverty rate, median household income, and the unemployment rate; these provide indicators of low and middle income and local jobs. Freudenburg and Wilson (2002) note that poverty, income, and unemployment are the most commonly used outcome indicators in mining studies. Furthermore, poverty, income, and unemployment are the three core indicators used by the Appalachian Regional Commission to measure communities' economic distress, which guides the allocation of funding from federal and other programs. For a discussion of the strength and limitations of poverty, income, and unemployment as well-being indicators and their use by the Appalachian Regional Commission and other agencies see Partridge et al. (2008).

Each dependent variable is measured in year 2000 and 2010. The models for 1990–2000 use the 2000 dependent variable while the models for 2000–2010 use the 2010 dependent variable. All models also include the lagged value of the dependent variable measured the decade prior, which provides a robust control for past local conditions. Poverty and median household income measures for 2000 and 1990 are from the U.S. Census of Population. Poverty and median household income for 2010 are from the U.S. Census Bureau Small Area Income and Poverty Estimates (SAIPE), which provide annual data covering all counties. These data cover the final year of the Great Recession decade while the American Community Survey produces only five-year averages for all counties. The SAIPE data are model-driven estimates and thus would not be as accurate as using data from the decennial census long form that was in effect through the 2000 census. However, this does not seem to be a major problem as the respective correlations between the SAIPE poverty rate and the 1990 and 2000 census poverty rates equal .95 and .94, suggesting that the SAIPE is a strong measure in absence of the long form. By contrast, the American Community Survey five-year

averages can have rather high standard errors given the small sample sizes for less-populated counties.[3]

Unemployment is measured by the official rate reported by the Bureau of Labor Statistics for 1990, 2000, and 2010. As often noted, nonemployed individuals must be *actively* seeking work to be officially considered unemployed.

Independent Variables

Coal Mining and Other Employment Sectors. Public data sources rarely allow disaggregation of coal from other mining and when they do, there are severe problems of missing (suppressed) data for small rural counties. We measure coal mining employment using proprietary data from Economic Modeling Specialists International (EMSI), which provide estimated values for employment by place of work at the four-digit North American Industry Classification System (NAICS) level: these data allow coal to be disaggregated from other mining and produce reliable estimates for small counties. The share of county total employment that is in coal is measured by dividing each county's employment in coal mining and coal mining support activities by total county employment.[4]

As noted, a key problem with secondary data sources is that they do not disclose information at the four-digit detailed industry level for

[3] If the dependent variable is measured with error, that would increase the standard error of the estimated regression coefficients and reduce the number of coefficients that attained statistical significance, but the coefficients would remain unbiased. So for the 2010 poverty and median household (SAIPE-based) models, the reported results for coal and other independent variables may be a little stronger than indicated by the significance levels of their coefficients.

[4] Almost all national studies on mining rely on secondary data that combine all mining sectors including oil and natural gas. EMSI data are constructed to address data suppression problems at the county level by combining federal data sources such as the Quarterly Census on Employment and Wages, County Business Patterns, and Bureau of Economic Analysis Regional Economic Information System (REIS) data to fill in suppressed observations. Dorfman, Partridge, and Galloway (2011) describe how EMSI constructs its data in more detail. A number of recent studies use the EMSI four-digit data including Betz et al. (2015); Dorfman et al. (2011); Fallah, Partridge, and Rickman (2014); Fallah, Partridge, and Olfert (2011); and Nolan et al. (2011). In our study, the county share of employment in coal mining is measured using the four-digit industry category coal mining employment (NAICS 2121). Mining support employment (NAICS 2131) is a separate four-digit category but it does not distinguish between coal and other mining. To account for coal support employment, we derive an approximate measure by multiplying the share of mining support attributable to coal mining nationally (about 3 percent in 2010) by the county's employment in total mining support. We add this figure to our base value of coal mining employment and divide by total county employment to get the share of employment in coal mining and coal mining support activities. Oil and gas employment in a county is also measured by including support activities.

most counties. One of the more popular secondary sources used to study industrial sectors is County Business Patterns (CBP) produced by the U.S. Census Bureau, U.S. Department of Commerce. For CBP, for counties for which the data are suppressed, six employment ranges up to 2,499 workers in the industry are given. For counties for which CBP reports coal employment, only 12 percent had an actual employment number in 1990, only 16 percent in 2000, and only 21 percent in 2010. With CBP data, coal employment could be analyzed by taking the midpoint of the respective six categories as a proxy for actual coal employment. When we did so, we found that the correlation between the 1990 EMSI and CBP coal employment share is .866 and the respective figures for 2000 and 2010 are .845 and .857. Thus, there is reasonable evidence that the EMSI data are quite accurate given the high correlation with CBP data and considering that the CBP data is measured by error due to the suppressions that would reduce the true correlation. As a further check, we reestimated our regression models using the CBP data.[5] We employ the EMSI data, however, because we believe it offers better precision, which is particularly important in the case of small rural counties. Nevertheless, as with all studies that require the use of estimated variables due to data suppression, the findings from the EMSI data should be interpreted with caution.

We also include other mining sectors, manufacturing, and services as control variables that allow for comparisons with coal mining. Four-digit NAICS EMSI data are used to measure the share of county employment in oil and gas mining and all other mining (i.e., metal and gravel). All other sectors are measured with EMSI two-digit data that aggregate industries into 20 sectors. For services, we select an upper and lower paying tier based on recent classifications (Holzer et al. 2011; NELP 2014). For the former, we aggregate finance and insurance; real estate; and professional, scientific, and technical services. The lower tier aggregates business-related administrative and support services and waste management and also accommodation and food services. We also include education, health, and social services to measure care-work–related industries. Analysts see care-work industries as a growth sector that is varied in employment quality with a relatively large segment of low- to median-income earners (Dwyer 2013; NELP 2014). Our purpose is to compare coal with several sectors commonly identified as

[5] The significance and direction of all relationships were the same as we found for the EMSI data—for seven of the eight models. In one model (ARC, poverty 2010), the direction was the same but the significance level was reduced to $p < .15$, which should not be surprising since there would be less precision in the estimates with CBP data given the lack of precision we described above.

influential to economic well-being today: high- versus low-wage services, manufacturing, and for our study, other mining.[6]

For coal and other employment variables, we create two sets of measures, the base share of employment in the county and the change in this share. Base employment share variables are lagged 10 years to be predetermined prior to the dependent variable to reduce endogeneity or mutual causality. Change in employment is measured as the difference between each share at each time point, hence the percentage point change measured as 2000–1990 and in turn, 2010–2000.

It should be noted that the U.S. Department of Agriculture Economic Research Service (2015) categorizes U.S. counties according to economic dependence on mining and by persistence of poverty. These categorizations are important to researchers and policy audiences. However, these are nonoverlapping categories whereas we are using gradations of both mining and poverty. The Economic Research Service mining category incorporates all types of mining whereas our focus is on coal mining.[7]

Population Attributes, Urban-Rural Location, and Other Control Variables. Studies from the place and poverty tradition also identify demographic attributes and location as well-being determinants and we include these as control variables. Counties whose demographic composition reflects greater structural inequalities of education, race or ethnicity, age, single-family status, and low labor market participation tend to have poorer well-being (Lichter and Cimbaluk 2012; Voss et al. 2006). We include variables measuring the proportion of college graduates; female single-headed families with children; population of children 17 and under; adult population over 65; and African American, other nonwhite, Hispanic, and foreign-born populations. We also include the employment-to-population ratio—the employed population to population age 16 and over—a measure of the aggregate strength of the local labor market (Partridge and Rickman 2006).

[6] Using the 20 aggregated two-digit NAICS sectors, we categorize services into two groups, the highest paying services and the lowest paying services. The highest paying services are FIRE or finance, insurance and real estate (NAICS 52 and 53) and professional/scientific services (NAICS 54). The lowest paying services are business support and food and accommodations (NAICS 56 and 72). We selected the sectors used in the models to provide some basis for comparing coal to other sectors recognized as influential today. Remaining NAICS sectors are not of specific interest and function as the excluded category in our models.

[7] Based on our data, for the Economic Research Service mining dependence category, the percentage of these counties above the national mean for coal employment for each year are, respectively: 1990, 42.4 percent; 2000, 43.4 percent; and 2010, 42.4 percent. For the Economic Research Service persistent poverty counties, the percentage of these counties above the national mean for coal employment are, respectively: 1990, 14.7 percent; 2000, 10.8 percent; and 2010, 10.2 percent.

These variables are also lagged in time prior to the dependent variables using data from the census of population for 1990 and 2000.

For county location, rather than a categorical measure of metro-nonmetro status, we use a more sensitive gradient measure, kilometers to the nearest metropolitan area. This variable measures distance using the population-weighted centroid (latitude and longitude) of the nearest metropolitan area. Nonmetro counties are coded in kilometer distance from the population-weighted centroid of the nonmetropolitan county to the population-weighted centroid of the nearest metropolitan area; metro counties are coded in kilometer distance from the population-weighted centroid of each county to the population-weighted centroid of the metropolitan area.[8] We follow procedures outlined by Partridge and Rickman (2008), who found that such distance measures better detect how urban-rural location influences county poverty and also account for differences in the geographical size of counties. While coal counties tend to be predominantly nonmetropolitan, they often differ from their other nonmetropolitan counterparts by being more remote from urban areas. As remoteness is a potential reason for why coal counties (especially in central Appalachia) lag in terms of economic well-being, including this variable would separate the remoteness effect from the coal effect in our estimated regression coefficients. We also include the log of county population size, and as noted below, the state in which the county is located.[9]

Finally, present levels of well-being are highly affected by past levels. As poverty, income, and unemployment are expected to have strong legacy effects, we include the respective dependent variable in each model lagged 10 years.

[8] For metro counties, the distance of the county to the center of its own metropolitan area is used to account for different growth rates of central and outer metropolitan area counties. For single-county metro areas, this distance is zero. We use the 2003 U.S. Census Bureau metropolitan area definitions. Partridge and Rickman (2008) report that distance is a more sensitive measure of rurality when analyzing poverty than are categorical measures of metro adjacency: rural counties' distance from urban agglomerations is more closely related to their poverty rates. We examined other distance measures using different-sized metro areas but results are similar. With regard to a different measure, travel time, it is possible that travel times using various transportation modes may not be entirely reflected by distance. However, regional scientists have explained why distance measures tend to be highly correlated with travel time (Combes and Lafourcade 2005). A direction for future research is to build from the human ecology framework to conceptualize the role of transportation and other infrastructure in a study focused on these issues.

[9] Our goal is to examine the entire United States and Appalachia. As two-thirds of U.S. and also Appalachian counties are nonmetro and our models control for nonmetro-metro status and rural distance, state location, and spatial effects, we report the results for the full populations and treat rural-urban and regional differences as a part of our models.

Table 1 provides descriptive statistics. Dependent variables refer to outcome years 2000 or 2010 while independent variables refer to the previous decade. Higher poverty (16.8 percent), lower income ($33,917), and higher unemployment (9.17 percent) are found in 2010 for the postrecession United States. In 2010 (relative to 2000), coal mining and manufacturing employment are lower and both high- and low-paying services are higher, which indicates service polarization. ARC counties fare worse on well-being. They have a greater share of coal mining and manufacturing and smaller share of high-wage services than the nation overall.[10]

In Figures 1, 2, and 3 we display maps for the three dependent variables for the 2010 time point with each variable categorized into quintiles. Figures 1 and 2 show that the spatial distribution of income-related variables, the poverty rate and median household income, is similar. Better conditions are found for the northeastern seaboard states, Great Plains states, and much of the West. Note that it is still a time of recovery from the Great Recession, when states in the Plains and West fared better in part because of the oil and natural gas boom (U.S. Census Bureau 2013). Worse conditions are found in central Appalachia, particularly eastern Kentucky, West Virginia, and southeastern Ohio. Figure 3 shows that the unemployment rate is lowest in the Plains states downward through Texas. By contrast, unemployment is highest across states particularly impacted by the Great Recession, eastern north central states suffering from the loss of manufacturing and western seaboard states affected by the collapse of the housing boom.

Analyses

Modeling Relationships

The multivariate models were developed to address methodological issues noted in the poverty and place literature including assumptions about regression analyses. First, with county-level data, researchers observe that data points are typically not independent as assumed in conventional (OLS) regression models, but rather spatially dependent: Observations at one location tend to be correlated to those from nearby locations (Rupasingha and Goetz 2007). Researchers are commonly concerned with spatial dependence of two forms, spatial lag, whereby the value of the dependent variable is directly affected by neighboring counties' values, and spatial error, whereby the disturbance term is

[10] In separate analyses we selected out the ARC counties from non-ARC counties and conducted difference-of-means tests. Statistically significant differences are found for all variables in Table 1 with the exception of two in 2010 (age over 65 and other mining).

Table 1. Descriptive Statistics.

	1990 – 2000[a]				2000 – 2010[a]			
	U.S.		ARC		U.S.		ARC	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Dependent variables								
Total poverty (%)	14.18	6.52	16.36	6.41	16.81	6.21	19.48	5.38
Median household income[b]	35,216.31	8,746.55	31,296.62	6,611.75	33,917.26	10,498.79	29,766.26	6,979.33
Unemployment rate (%)	4.34	1.64	4.99	1.50	9.17	3.13	10.71	2.34
Local economic structure (%)								
Share coal	0.48	2.79	2.11	6.43	0.26	1.80	1.13	4.20
Share oil and gas	1.16	3.22	0.80	2.23	0.91	2.72	0.71	2.08
Share other mining	0.69	3.23	0.44	0.85	0.48	2.56	0.35	0.79
Share manufacturing	16.74	11.99	24.16	13.06	14.31	10.50	19.49	11.23
Share high-paying services	9.05	4.14	7.70	3.24	9.92	4.27	8.47	3.11
Share education, health, social	8.98	4.54	9.06	5.45	10.61	4.77	11.33	5.34
Share low-paying services	8.96	4.76	7.88	4.15	10.79	5.02	10.00	4.46
Population attributes and location								
Kilometers from MSA	72.321	60.282	52.887	31.689	72.321	60.282	52.887	31.689
Population	80407	266452	51732	89145	90849	295484	56374	92064
Percent foreign born	0.48	0.96	0.15	0.34	0.92	1.32	0.52	0.83
Percent college graduate	13.41	6.44	10.44	4.95	16.42	7.66	12.92	5.87
Percent female-headed households	5.40	2.30	5.18	1.57	6.08	2.39	5.74	1.64
Age ≤ 17	26.88	3.46	25.30	2.52	25.50	3.14	23.75	2.30
Age > 65 (%)	14.96	4.34	14.35	2.65	14.83	4.11	14.56	2.76
African American (%)	8.54	14.34	5.83	10.78	8.69	14.48	6.04	10.98
Non–African American (%)	3.89	7.60	0.78	1.59	6.45	8.85	2.28	2.24
Hispanic (%)	4.43	11.13	0.47	0.44	6.19	12.18	1.41	1.95
Employment population ratio (%)	58.25	7.24	54.72	7.32	58.14	7.49	54.46	7.01
Other control variables								
Total poverty (lagged) (%)	16.74	7.90	19.04	7.91	14.18	6.52	16.36	6.41
Median household income (lagged)[b]	31,354.31	6,383.85	28,143.42	4,740.64	35,216.31	8,746.55	31,296.62	6,611.75
Unemployment rate (lagged) (%)	6.12	2.91	7.75	2.75	4.34	1.64	4.99	1.50

Note: ARC = Appalachian Regional Commission. MSA = metropolitan statistical area.
[a]Dependent variables are measured in the later time point and independent variables in the earlier time point.
[b]Constant 2000 dollars are reported.

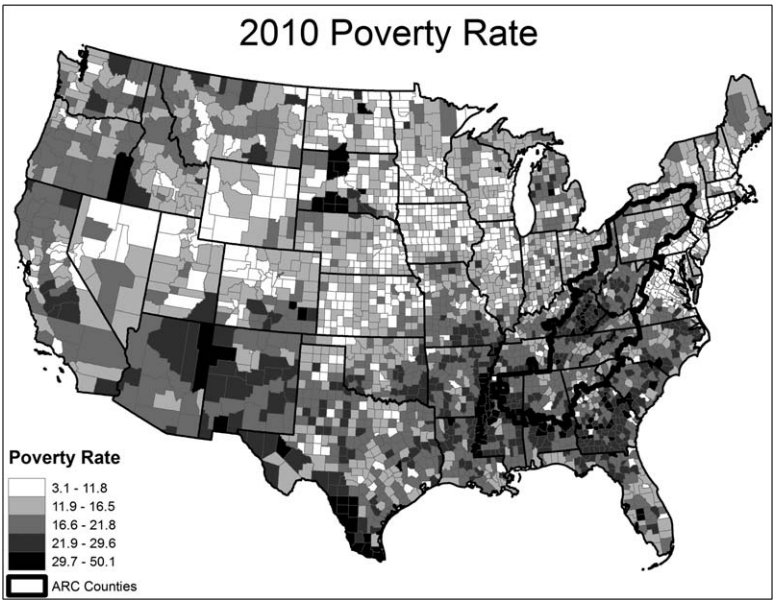

Figure 1. The Poverty Rate across U.S. and Appalachian Regional Commission (ARC) Counties.

affected due to some omitted but unknown variable with a spatial dimension. Spatial regression methods allow researchers to account for dependence between observations that are in close geographical proximity by including a spatially lagged dependent variable as an explanatory variable or allowing the disturbances to be spatially correlated (Anselin 1988). Our specific empirical models are chosen based on diagnostic tests. We first tested data for global spatial autocorrelation (i.e., spatial dependence). We performed three tests (Moran's I, Geary's C, and Getis's and Ord's G), with test statistics showing positive spatial autocorrelation in our dependent variables. Next, using spatial diagnostics and Lagrange multiplier tests, we also find that for most models spatial dependence is present in the error term or disturbance as well as the lagged dependent variable. In such cases, statistical inference from ordinary least squares regression may be unreliable and the general spatial model that includes both the lag and the spatial error structure is appropriate. We thus estimate a general version of the spatial model, also known as the SARAR model, a spatial autoregressive model with spatial-autoregressive disturbances (see Drukker, Prucha, and Raciborski 2013). This model includes both a spatial lagged term (a weighted average of the dependent variable) and a spatially

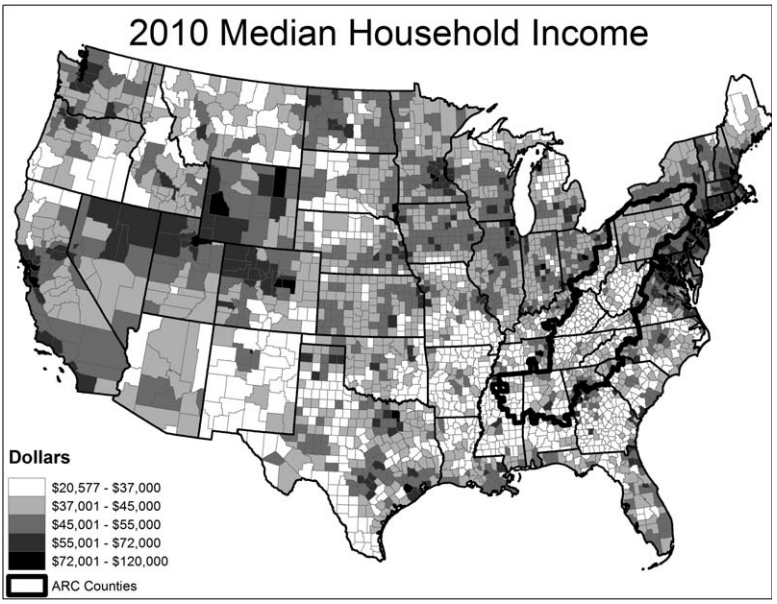

Figure 2. Median Household Income across U.S. and Appalachian Regional Commission (ARC) Counties.

correlated error structure (the disturbance term is allowed to depend on a weighted average of the disturbances of other units), compactly shown as:

$$y = \rho W_1 y + X\beta + u \quad [1]$$

$$u = \lambda W_2 u + \varepsilon \quad [2]$$

$$\varepsilon \sim N\left(0, \sigma_\varepsilon^2 I_n\right) \quad [3]$$

where y is the dependent variable, X is a vector of explanatory variables, β is a vector of regression coefficients, and both u and ε are error terms. ρ and λ are corresponding spatial autorregressive parameters; W_1 and W_2 are spatial weighting matrices; in many applications $W_1 = W_2$. ε is normally distributed with mean 0 and variance $\sigma_\varepsilon^2 I_n$.[11]

Second, we tested all models to ensure that unacceptable levels of multicollinearity are not present. Correlations between mining

[11] The spatial weight matrix W is a modified version of the Stata module USSWM that provides county spatial weight (contiguity) matrices for the 48 contiguous states. We use the updated data for this matrix produced for Stata by Scott Merryman (last revision in August 2008).

Figure 3. The Unemployment Rate across U.S. and Appalachian Regional Commission (ARC) Counties.

variables were low, the highest ($r = 0.154$) found in Appalachia for 2000 between oil and gas and coal. Our more detailed data on mining thus shows that coal industry employment does not highly overlap with employment in gas and oil. Variance inflation factors for the variables used in the models are low to moderate. The mean variance inflation factors range from 2.32 to 2.55 across models. The highest variance inflation factor (5.91) for any variable included in the models is for a control variable, the percentage female-headed households in the 2010 U.S. poverty model.

Third, we include state fixed effects to account for differences between states that could influence relationships. For example, state fixed effects would account for state government policies and economic history that influence all the counties within a state.

Fourth, independent and included dependent variables are lagged to the previous decade to better assess causal relationships and reduce the concern of endogeneity or simultaneous relationships (mutual causality) that would be more likely to occur if all variables were analyzed at the same time point. However, our study like most other sociological studies is limited because unmeasured factors in the county or neighboring counties still could affect past local economic structure and in

turn future well-being.[12] To minimize this potential concern, we included controls for lagged dependent variables and used spatial analytical models to control for conditions in surrounding counties.

Finally, we considered other specifications of the models and performed additional analyses. We created change-level measures of the three dependent variables for each decade. The results for these models follow closely those reported here using the level variables, demonstrating that change-level dependent variable models provide similar information about well-being over each decade. Another potential way of specifying the relationships would be to exclude Appalachia from the U.S. analysis. However, one of our goals is to take advantage of the complete data set to consider national-level debates about coal mining and not only the case of Appalachia. We reanalyzed the relationships excluding Appalachian counties. The results here are very similar to those reported in the article: this would be expected since Appalachian counties account for just 14 percent of the U.S. counties. In sum, because the two sets of aforementioned analyses yield results so similar to those reported in the article, we do not include tables for them; these tables are available from us.

In Tables 2–4, we present the multivariate results of this study. Each table displays models for the two decades analyzed. The first set of models refers to the 1990–2000 decade (with the dependent variables measured in 2000) and the second set refers to the 2000–2010 decade (with the dependent variables measured in 2010). As coal employment, other employment sectors, poverty, and unemployment are all expressed in percentage point form, unstandardized coefficients (reported in the tables) allow for a similar comparison on a simple percentage point basis. Standardized coefficients for the models are reported in the Appendix.[13]

To condense discussion of the results, we focus on the relationships between coal employment and socioeconomic well-being, including

[12] For example, lagged economic structure variables still could be correlated with the residuals (conditional on the other control variables) if historical conditions influence these lagged variables and in turn, influence subsequent economic well-being. However, sociological studies of counties' well-being rarely if ever control for historical determinants of economic structure with no precedent for doing so. Our findings must be qualified because like virtually all other quantitative studies, we cannot control for historical forces that produced contemporary mining employment. Focusing on Appalachia and including a state-control variable, however, help to hold constant historical forces to some degree insofar as counties share similar regional histories.

[13] The models featuring the standardized coefficients report only the direct effects of the variable, not any indirect feedback effects through the *WY* term. By contrast, these feedback effects are built into the models featuring the unstandardized coefficients.

Table 2. Spatial Regressions of the Poverty Rate across U.S. and Appalachian Counties.

	1990–2000[a]				2000–2010[a]			
	Total Poverty U.S.		Total Poverty ARC		Total Poverty U.S.		Total Poverty ARC	
Local economic structure								
Share coal	0.044	(0.027) +	0.015	(0.028)	−0.086	(0.024)***	−0.071	(0.028)*
Share oil and gas	0.085	(0.017)***	−0.046	(0.048)	−0.075	(0.018)***	0.063	(0.076)
Share other mining	−0.010	(0.017)	−0.030	(0.110)	−0.029	(0.016) +	−0.102	(0.119)
Share manufacturing	0.015	(0.005)**	0.018	(0.013)	0.004	(0.006)	0.021	(0.016)
Share high-paying services	−0.071	(0.017)***	−0.071	(0.048)	−0.044	(0.014)**	−0.122	(0.052)*
Share education, health, social	0.025	(0.011)***	0.030	(0.026)	0.016	(0.010)	−0.007	(0.024)
Share low-paying services	−0.041	(0.011)***	0.021	(0.030)	0.007	(0.010)	0.041	(0.030)
Change in local economic structure								
Change coal	−0.037	(0.054)	−0.125	(0.057)*	−0.026	(0.045)	−0.109	(0.064) +
Change oil and gas	0.201	(0.042)***	−0.214	(0.149)	0.019	(0.023)	−0.025	(0.094)
Change other mining	−0.021	(0.036)	0.306	(0.198)	−0.062	(0.039)	−0.352	(0.196) +
Change manufacturing	−0.013	(0.009)	−0.046	(0.021)*	−0.038	(0.011)***	−0.056	(0.030) +
Change high-paying services	0.000	(0.020)	−0.124	(0.073) +	−0.045	(0.018)*	−0.173	(0.069)*
Change education, health, social	0.086	(0.018)***	0.113	(0.044)*	0.031	(0.015)*	−0.043	(0.050)
Change low-paying services	−0.038	(0.014)**	−0.040	(0.041)	0.033	(0.015)*	0.050	(0.052)
Population attributes and location								
Kilometers from MSA	0.005	(0.001)***	0.005	(0.004)	−0.002	(0.001)	0.011	(0.004)**
Log population	0.024	(0.059)	0.429	(0.161)**	0.406	(0.055)***	0.193	(0.175)
Percent foreign born	0.362	(0.064)***	1.505	(0.474)**	0.052	(0.047)	0.327	(0.305)
Percent college graduate	0.053	(0.012)***	0.010	(0.042)	−0.076	(0.010)***	−0.067	(0.034) +
Percent female-headed households	0.162	(0.040)***	−0.209	(0.120) +	0.256	(0.040)***	0.499	(0.140)***
Age ≤ 17	−0.026	(0.024)	0.062	(0.075)	−0.267	(0.022)***	−0.253	(0.078)**

Table 2. *Continued*

	1990–2000[a]				2000–2010[a]			
	Total Poverty U.S.		Total Poverty ARC		Total Poverty U.S.		Total Poverty ARC	
Age > 65	−0.044	(0.017)**	−0.099	(0.057) +	−0.065	(0.016)***	−0.005	(0.054)
African American	0.021	(0.006)***	0.063	(0.019)***	0.010	(0.006)	−0.026	(0.020)
Non–African American	0.059	(0.009)***	−0.138	(0.064)*	0.035	(0.008)***	−0.080	(0.060)
Hispanic	−0.007	(0.007)	0.048	(0.265)	0.005	(0.007)	0.046	(0.123)
Employment/ population ratio	−0.056	(0.012)***	−0.121	(0.036)***	−0.093	(0.012)***	−0.027	(0.040)
Poverty rate (lagged)	0.624	(0.012)***	0.640	(0.036)***	0.705	(0.013)***	0.644	(0.042)***
Intercept	5.717	(1.286)***	5.148	(3.899)	15.078	(1.201)***	11.715	(3.835)**
Lambda	0.072	(0.017)***	0.029	(0.043)	0.001	(0.017)	0.063	(0.055)
Rho	0.155	(0.035)***	0.134	(0.094)	0.286	(0.034)***	−0.105	(0.114)
Pseudo R2	0.899		0.930		0.895		0.878	
N	3072		420		3072		420	

Note: ARC = Appalachian Regional Commission. MSA = metropolitan statistical area. Standard errors in parentheses. + $p < .10$, * $p < .05$, ** $p < .01$, *** $p < .001$.

[a]Poverty measured at later time point.

Table 3. Spatial Regressions of Median Household Income (log) across U.S. and Appalachian Counties.

	1990–2000[a]				2000–2010[a]			
	Median Household Income U.S.		Median Household Income ARC		Median Household Income U.S.		Median Household Income ARC	
Local economic structure								
Share coal	−0.166	(0.078)*	−0.183	(0.082)*	0.356	(0.065)***	0.345	(0.068)***
Share oil and gas	−0.499	(0.052)***	−0.187	(0.146)	0.380	(0.049)***	0.117	(0.174)
Share other mining	0.053	(0.049)	−0.036	(0.315)	0.095	(0.044)*	0.158	(0.269)
Share manufacturing	−0.038	(0.016)*	−0.124	(0.039)**	−0.040	(0.017)*	−0.021	(0.037)
Share high-paying services	0.268	(0.051)***	0.249	(0.137)+	0.217	(0.038)***	0.327	(0.118)**
Share education, health, social	−0.092	(0.032)**	−0.117	(0.073)	−0.049	(0.027)+	0.033	(0.053)
Share low-paying services	0.089	(0.033)**	−0.158	(0.085)+	−0.043	(0.028)	0.001	(0.070)
Change in local economic structure								
Change coal	0.283	(0.158)+	0.366	(0.161)*	0.147	(0.118)	0.053	(0.144)
Change oil and gas	−0.531	(0.121)***	0.315	(0.414)	0.391	(0.061)***	0.120	(0.213)
Change other mining	0.273	(0.104)**	−0.230	(0.564)	0.263	(0.104)*	0.426	(0.444)
Change manufacturing	0.085	(0.027)**	0.148	(0.058)*	0.144	(0.030)***	0.117	(0.067)+
Change high-paying services	0.070	(0.059)	0.272	(0.208)	0.198	(0.049)***	0.311	(0.157)*
Change education, health, social	−0.258	(0.053)***	−0.288	(0.125)*	−0.046	(0.041)	0.037	(0.115)
Change low-paying services	0.070	(0.042)+	−0.109	(0.114)	−0.029	(0.040)	−0.085	(0.117)
Population attributes and location								
Kilometers from MSA	−0.019	(0.003)***	0.005	(0.013)	0.005	(0.003)	−0.031	(0.011)**
Log population	−0.601	(0.175)***	−1.559	(0.468)***	−0.760	(0.149)***	−0.527	(0.415)
Percent foreign born	−0.693	(0.192)***	−4.760	(1.333)***	−0.320	(0.127)*	−1.323	(0.687)+
Percent college graduate	0.090	(0.037)*	0.178	(0.120)	0.193	(0.027)***	0.326	(0.082)***
Percent female-headed households	−0.487	(0.117)***	0.484	(0.337)	−0.689	(0.105)***	−0.314	(0.313)
Age ≤ 17	0.319	(0.070)***	−0.138	(0.214)	0.567	(0.061)***	0.261	(0.187)
Age > 65	−0.056	(0.051)	−0.137	(0.168)	−0.307	(0.042)***	−0.601	(0.124)***
African American	−0.067	(0.019)***	−0.182	(0.055)**	−0.056	(0.018)**	−0.150	(0.047)**
Non–African American	−0.068	(0.025)**	0.405	(0.183)*	−0.108	(0.022)***	−0.103	(0.139)
Hispanic	−0.027	(0.021)	1.112	(0.757)	−0.022	(0.018)	0.051	(0.281)

Table 3. ***Continued***

	1990–2000[a]				2000–2010[a]			
	Median Household Income U.S.		**Median Household Income ARC**		**Median Household Income U.S.**		**Median Household Income ARC**	
Employment/population ratio	0.013	(0.035)	0.273	(0.096)**	−0.113	(0.031)***	−0.158	(0.085) +
Median household income (lagged)	75.133	(1.293)***	72.045	(3.571)***	85.122	(1.156)***	76.816	(3.263)***
Intercept	1.683	(0.152)***	2.294	(0.456)***	1.645	(0.145)***	2.468	(0.407)***
Lambda	0.115	(0.014)***	0.094	(0.040)*	0.016	(0.013)	0.026	(0.036)
Rho	0.267	(0.033)***	0.262	(0.095)**	0.357	(0.029)***	0.226	(0.091)*
Pseudo R2	0.928		0.943		0.941		0.938	
N	3072		420		3072		420	

Note: ARC = Appalachian Regional Commission. MSA = metropolitan statistical area. Standard errors in parentheses. + $p < .10$, * $p < .05$, ** $p < .01$, *** $p < .001$. Coefficients displayed as *b x 100*.

[a]Income measured at later time point.

Table 4. Spatial Regressions of the Unemployment Rate across U.S. and Appalachian Counties.

	1990–2000[a]				2000–2010[a]			
	Unemployment Rate U.S.		Unemployment Rate ARC		Unemployment Rate U.S.		Unemployment Rate ARC	
Local economic structure								
Share coal	0.002	(0.009)	0.002	(0.012)	−0.048	(0.016)**	−0.045	(0.019)*
Share oil and gas	0.005	(0.006)	0.049	(0.023)*	−0.030	(0.012)*	0.040	(0.051)
Share other mining	−0.009	(0.006)	−0.024	(0.047)	−0.015	(0.011)	0.154	(0.080)+
Share manufacturing	−0.003	(0.002)	−0.003	(0.006)	0.023	(0.004)***	0.029	(0.011)**
Share high-paying services	−0.003	(0.006)	−0.002	(0.020)	0.010	(0.009)	0.011	(0.034)
Share education, health, social	−0.012	(0.004)**	−0.007	(0.010)	−0.011	(0.006)+	−0.002	(0.016)
Share low-paying services	−0.005	(0.004)	−0.007	(0.013)	0.032	(0.007)***	0.009	(0.021)
Change in local economic structure								
Change coal	−0.037	(0.019)+	−0.043	(0.025)+	−0.123	(0.028)***	−0.148	(0.043)***
Change oil and gas	−0.013	(0.014)	0.059	(0.064)	−0.062	(0.015)***	−0.162	(0.063)*
Change other mining	−0.046	(0.012)***	0.138	(0.085)	−0.139	(0.024)***	−0.281	(0.132)*
Change manufacturing	−0.025	(0.003)***	−0.044	(0.009)***	−0.073	(0.007)***	−0.092	(0.020)***
Change high-paying services	−0.017	(0.007)*	−0.041	(0.031)	−0.024	(0.012)*	0.037	(0.048)
Change education, health, social	0.002	(0.006)	0.007	(0.019)	−0.017	(0.010)+	0.001	(0.034)
Change low-paying services	−0.022	(0.005)***	−0.067	(0.017)***	−0.016	(0.009)+	0.007	(0.035)
Population attributes and location								
Kilometers from MSA	0.001	(0.000)*	−0.000	(0.002)	−0.004	(0.001)***	0.002	(0.003)
Log population	−0.045	(0.020)*	0.026	(0.067)	0.034	(0.035)	−0.102	(0.118)
Percent foreign born	0.129	(0.023)***	0.157	(0.193)	0.002	(0.031)	−0.147	(0.199)
Percent college graduate	−0.014	(0.004)**	−0.038	(0.018)*	−0.046	(0.006)***	−0.074	(0.023)**
Percent female-headed households	0.048	(0.013)***	0.122	(0.052)*	0.053	(0.024)*	0.053	(0.091)
Age ≤ 17	0.014	(0.008)	0.007	(0.033)	0.033	(0.014)*	0.083	(0.053)
Age > 65	0.016	(0.006)**	0.045	(0.024)+	−0.006	(0.010)	−0.036	(0.035)
African American	0.012	(0.002)***	0.003	(0.008)	0.014	(0.004)***	0.032	(0.013)*
Non–African American	0.014	(0.003)***	0.076	(0.027)**	−0.020	(0.005)***	0.043	(0.041)
Hispanic	0.005	(0.003)*	−0.008	(0.111)	−0.003	(0.005)	0.062	(0.081)

Table 4. ***Continued***

	1990–2000[a]				2000–2010[a]			
	Unemployment Rate U.S.		Unemployment Rate ARC		Unemployment Rate U.S.		Unemployment Rate ARC	
Employment/population ratio	−0.039	(0.004)***	−0.042	(0.013)**	−0.020	(0.008)**	−0.044	(0.021)*
Unemployment rate (lagged)	0.258	(0.008)***	0.169	(0.022)***	0.928	(0.028)***	0.608	(0.079)***
Intercept	3.700	(0.434)***	3.147	(1.482)*	4.941	(0.844)***	5.670	(2.223)*
Lambda	0.158	(0.026)***	0.259	(0.143)+	0.044	(0.034)	0.200	(0.085)*
Rho	0.298	(0.038)***	−0.057	(0.237)	0.508	(0.038)***	−0.032	(0.125)
Pseudo R2	0.789		0.763		0.803		0.702	
N	3072		420		3072		420	

Note: ARC = Appalachian Regional Commission. MSA = metropolitan statistical area. Standard errors in parentheses. + $p < .10$, * $p < .05$, ** $p < .01$, *** $p < .001$.

[a]Unemployment measured at later time point.

how coal compares with other sectors. We note briefly relationships for other control variables.

Coal Mining Employment and Poverty

Table 2 presents the results of the analysis for coal employment and poverty. As noted, for these and other models we use both the base year for coal and other employment as well as change in the employment sector over the respective decade. This allows assessment of coal employment in a twofold manner: how past levels of coal employment influence future poverty paths—and in turn how contemporaneous growth or decline in coal employment altered well-being outcomes over the decade.

The first set of models refers to the 1990–2000 period. For the U.S. analysis, counties with greater coal employment in 1990 had somewhat higher poverty rates in 2000 (beta = 0.044, $p < .10$). This relationship follows Freudenburg and Wilson (2002), who report in their meta-analysis that detrimental impacts are more likely to occur in eras of lower energy prices. Similarly, counties with a greater share of oil and gas employment in 1990 fared worse in 2000. For example, a single percentage point increase in the share of coal employment in 1990 would raise the future (2000) county poverty rate by .044 (net of control variables and relative to the excluded sector).[14] A single percentage point increase in oil and gas raises the future poverty rate by .085, moving the national mean rate up from 14.18 percent to 14.26 percent.

Considering other sectors in the 1990s, counties with greater manufacturing employment also lost ground and had significantly higher poverty, suggesting the impact of protracted deindustrialization. Counties with greater employment in education, health, and social services in 1990 also experienced higher poverty. These care-related industries tend to have low to medium job quality but are also more publicly funded, which may explain their association with poverty.[15] By contrast, for other service sectors, both high- and low-paying industries were

[14] In studies using county-level regression models for the proportion employed in various sectors, the coefficients for variables are relative to the excluded sector. In this manner, the coefficients allow comparison across all sectors included in the model.

[15] Counties with a higher share of education, health, and social services employment may have future poorer income-related conditions due to local job quality and because the public sector tends to be associated with lower income relative to the private sector (Dwyer 2013; Lobao and Hooks 2003). The public sector is conventionally expected to be associated with lower unemployment because jobs are more stable (Hodson 1983). Based on the comments of one reviewer, we inserted the proportion of the population age group 18–24 as a proxy for the proportion of college students. It had no effect on the significance and direction of the education, health, and social services employment variable as reported in any of the six models.

related to significantly lower poverty. This suggests private-sector service industries particularly bolstered local economies over the decade with low-wage services potentially providing jobs to less-advantaged workers. The 1990s were a decade of declining poverty when disadvantaged workers made greater strides (Partridge and Rickman 2006).

As for changes in local economic structure, growth in coal employment over 1990–2000 had no significant association with poverty. Similar to findings above for employment levels, employment growth in oil and gas and education, health, and social services was associated with higher poverty. In turn, growth in the lower wage service sector was associated with greater inroads against poverty.

With regard to population and location attributes, most relationships follow expected directions. More remote rural counties had higher poverty (net of their 1990 rate, which is controlled in the models). Counties with a higher share of non-Hispanic minorities, female-headed households, and foreign-born populations, and a lower employment-to-population ratio had significantly higher poverty. By contrast, counties with less-educated populations gained greater ground; again, this likely reflects the more robust national economy of the 1990s, when opportunities expanded for less-educated workers (Partridge and Rickman 2006). Finally, the lagged (1990) poverty rate is highly related to the 2000 poverty rate as expected, demonstrating the persistence of past conditions in carrying forward to influence future development paths.

The second model in Table 2 presents results for ARC counties. Counties where coal employment was higher in 1990 did not fare significantly better or worse from others in the region. But notably, no other employment sectors were related to better future outcomes. In a historically depressed region like Appalachia, past sectoral differences in employment may matter less to future well-being than the quantity of employment overall. However, the employment change variables indicate that where counties expanded their share of coal employment, poverty was lower. Poverty was also lower in counties where the share of manufacturing and high-wage services grew and where care-related services grew less or declined relative to other sectors. We note briefly some relationships for the demographic control variables. In contrast to the nation overall, ARC urban and rural counties did not fare significantly differently. Other relationships follow generally expected directions. ARC counties with a larger African American population and foreign born population experienced higher poverty over the decade while those with greater labor market strength or a higher employment-to-population ratio had lower poverty. As shown by the lagged dependent variable, past levels of poverty are highly associated with future levels.

For the 2000–2010 period, the third model in Table 2 shows that national relationships shifted from the previous decade. Counties with a greater share of coal mining employment had significantly lower poverty in 2010. As this decade reflects rising coal prices and an energy industry boom, coal mining can be expected to have more beneficial effects based on the natural resources sociology literature. Oil and gas and other mining jobs also are associated with lower poverty. By contrast, for other sectors, only high-paying services are associated with lower poverty over time. Mining employment thus appears to have allowed for some resilience against rising poverty over the decade spanning the Great Recession.

As for change-level employment variables, net of their level effects, coal and other mining industries do not significantly influence poverty. For other sectors, there are some differences from the 1990s decade. Job growth in manufacturing is associated with lower poverty, indicating that when manufacturing can be sustained, communities fare better. Service-sector growth has a more bifurcated relationship with poverty. Growth in higher paying services is associated with lower poverty, while growth in lower paying services is related to higher poverty, suggesting dampening opportunities for lower skilled, disadvantaged populations during the decade. As counties' share of education, health, and social services grew, the poverty rate also increased. More remote rural counties did not experience significantly higher poverty in this decade.

For Appalachia, like the nation, counties with a greater share of coal employment in 2000 had lower poverty rates in 2010. Unlike the nation, however, oil and gas employment are not significantly related to poverty: the share of these industries is lower in Appalachia (see Table 1) as was their post-2000 growth. For other base-level employment sectors, only the higher-paying service sector is significantly related to lower poverty. Where counties increased their share of coal employment over the 2000–2010 period, poverty was also slightly lower. Counties with a greater growth in high-paying services had lower poverty in 2010. Remote, rural Appalachian counties experienced significantly higher poverty rates over the past decade than other counties.

Coal Mining Employment and Median Household Income

In Table 3, we present the results for coal employment's influence on median household income levels. The models use the log value of income to minimize skewness. Most results mirror the findings for poverty, reinforcing the direction of coal mining's effects. As shown in the first model for the nation, the 1990 coal employment share was related to lower household income in 2000, again supporting the natural

resources sociology literature, which expects more detrimental impacts during eras of low prices. Oil and gas employment are also related to lower income. Other relationships for base economic structure follow relationships in the poverty models. Both higher and lower paying services are related to income gains over the decade while manufacturing and education, health, and social services are related to lower income. Where coal mining grew from 1990–2000, median household income rose slightly ($p < .10$), coal potentially adding some higher income jobs for local workers. For changes in other economic sectors and for most control variables, relationships are similar to those found in the poverty model. More remote rural counties had lower income over time.

For ARC counties, the 1990 base-level coal mining employment share was related to significantly lower household income over the decade. Appalachian counties with a greater share of manufacturing employment also had significantly lower income. Changes in economic structure follow those found in the poverty model. Notably, where growth in coal employment occurred, incomes were higher. Rural and urban counties in Appalachia did not fare significantly differently in household income gains over the decade as was found likewise for the poverty model.

In regard to the 2000–2010 decade for the nation, the relationship between coal employment and income becomes significantly positive. Base levels of oil and gas, other mining, and high-paying services all are related to higher income over this decade just as they were with lower poverty. By contrast, counties starting the decade with a greater share of manufacturing had lower income. Change-level measures also show that growth in oil and gas also are related to higher income, as would be expected from the boom in these sectors during the 2000–2010 decade. Growth in other mining, manufacturing, and higher paying services is also associated with income gains.

For Appalachia, counties with a higher share of coal employment in 2000 had higher income in 2010. But with the exception of higher paying services, no other sectors are significantly related to income, suggesting the less diverse, sluggish economy of the region. Where higher paying services grew, income was higher. Similar to the relationships found in the poverty models, more remote rural counties in the region had lower income gains.

In sum, over the 2000–2010 decade the often assumed relationship between coal mining employment and greater poverty and lower income appears to have reversed. During this decade, coal mining employment appears to be more beneficial than some other sectors and this is especially true in Appalachia, where only higher wage services offer better employment outcomes.

Coal Mining Employment and Unemployment

Table 4 presents the results for the unemployment rate. The first set of models shows that U.S. counties' share of coal employment in 1990 was not significantly related to subsequent unemployment. In this sense, coal employment was similar to that of gas and oil, other mining, and most other sectors, which also did not vary significantly in their relationship with future unemployment. As noted previously, the 1990s was a more prosperous era for the general economy and our findings suggest that industrial sectors performed relatively evenly with regard to generating employment opportunities. However, education, health, and social services are related to lower unemployment; this follows economic sociological research that explains that the public sector tends to produce greater job stability (Hodson 1983). In regard to indicators of change, growth in coal employment was associated with slightly lower unemployment over time ($p < .10$). However, growth in other sectors, especially other mining, manufacturing, and lower wage services, has a statistically significant relationship to lower unemployment. Demographic and location variables generally follow expected directions. Remote rural counties had significantly higher unemployment. Past unemployment had a significant effect on future rates: each one percentage-point increase in the lagged unemployment rate was associated with the 2000 unemployment rate being over quarter of a percentage point (0.258) higher.

For the ACR counties, the relationships for coal are similar to those nationally. The base level of coal employment is not significantly associated with unemployment. In contrast, counties with higher base levels of gas and oil employment did not fare well. As found nationally, growth in coal over the decade was associated with a slightly lower future county unemployment rate ($p < .10$) while growth in manufacturing and lower wage services was related to significantly lower unemployment rates.

For the recent 2000–2010 decade, the national results for coal employment follow the models for poverty and income in showing a shift toward more positive labor market outcomes of the energy industries. Counties having a greater share of coal employment at the start of the decade had significantly lower unemployment. Counties with greater gas and oil employment fared similarly. These relationships contrast with those for most other industries. Notably, counties with a greater share of manufacturing and lower wage services experienced significantly higher unemployment, indicating the drying up of opportunities for blue-collar and less-skilled workers over the decade. However, where growth in manufacturing and other sectors occurred, counties experienced declines in unemployment. Remote rural

counties had lower unemployment over the decade, which would be expected from the booming energy economy and the recession's more dramatic impact on urban areas (U.S. Census Bureau 2013).

For the ARC region, counties with a greater share of coal employment in 2000 had lower unemployment in 2010. No other base-level sectors significantly contributed to reducing the region's unemployment rate. By contrast, ARC counties with a greater share of manufacturing in 2000 had higher unemployment over the decade. For counties where coal employment grew, unemployment also was lower. Growth in gas and oil and manufacturing likewise was associated with lower unemployment. Past levels of unemployment are closely related to future levels. A one percentage-point increase in unemployment in 2000 is associated with the 2010 rate being over half a percentage point higher (i.e., 0.61). As shown in this and other models, the relatively weak influence of other sectors besides coal on economic well-being makes Appalachia particularly vulnerable to the fortunes of the industry.

In evaluating the findings of this study, we note several limitations. First, although commonly used in scholarly and policy work, indicators of poverty, income, and unemployment do not tap the full range of distress experienced by communities. The unemployment rate, for example, does not account for discouraged workers no longer seeking employment and thereby underestimates distress. Economic well-being indicators do not tap the extensive environmental damages suffered by Appalachia. Second, as discussed earlier, the findings need to be interpreted with caution as coal mining employment data are suppressed for most counties and the EMSI data are estimates. Finally, our analyses cannot account for factors prior to 1990 that have historically disadvantaged communities.

Conclusions

The impacts of coal employment remain controversial. We draw together two rural sociological research traditions to address current debates framed at the national level and for Appalachia facing a broad transition from the coal industry. The poverty and place literature is our touchstone, providing an analytical framework for comparatively analyzing economic sectors across the nation. We extend this literature to new questions about coal mining as an economic sector. This literature suggest that coal employment today may have mixed or more positive effects on income and reduced poverty than some other industries. We also draw from natural resources sociology. This literature has traditionally pointed to the negative impacts of mining over the long term but also stresses that positive impacts may exist in boom periods. We

advance both literatures by providing a new view of coal employment through the decade of the great recession. Our results generally support the insights generated by both traditions.

Coal mining employment's relationship to poverty, median household income, and unemployment varies both relative to period and other industries. In the 1990–2000 decade of better national conditions outside the energy sector, U.S. counties with greater coal employment in 1990 had higher poverty and lower income at the close of the decade. Net of the base level of coal employment, growth in coal employment was related to slightly higher income and lower unemployment. While coal employment tended to have a mixed influence nationally, employment in the gas and oil industry had a negative relationship to well-being over the 1990–2000 decade. For ARC counties, coal employment was similar to that in other industries in its lack of base-level association with poverty. However, ACR counties with greater coal employment in 1990 experienced lower income in 2000.

In the next decade of higher energy prices and a profound recession, the previous relationships shift. U.S. counties with greater coal employment in 2000 had lower poverty, higher income, and lower unemployment in 2010, relationships similar in direction to those for high-paying services—and dissimilar to those for manufacturing. For ARC counties, only coal and higher paying services are related to lower poverty and higher income. In comparison, manufacturing is associated with higher unemployment for the United States and the ARC region over the 2000–2010 decade. The findings indicate a continued hollowing out of economic opportunities for communities and blue-collar workers who have depended on manufacturing.

This study advances the place and poverty tradition by pointing to the need for greater attention to mining in the postrecession period. As this tradition conventionally focuses on manufacturing and services, our findings for coal as well as gas and oil highlight the importance of scrutinizing employment shifts in energy sectors that are creating new rounds of poverty and prosperity across the nation. For natural resources sociology, our findings indicate that research often confined to a limited number of rural communities could be extended to a larger scope of localities nationally. The findings further show the coal mining industry is related to economic instability across periods. Finally, by building from the place and poverty and natural resource traditions, our findings highlight why a just transition from coal will require moving communities toward economic sectors that offer a better future.

For Appalachia this study has several implications. First, the range of economic sectors that outperform others in future beneficial effects

appears considerably limited. In the 2000–2010 decade, coal mining and high-wage services have the most consistent relationship with higher household income and lower poverty across the region. Second, beyond high-wage services, which face obvious barriers to expansion such as distance from urban centers and the need for advanced education, employment opportunities that can improve economic well-being are not immediately apparent. Third, the findings have implications for a political economy of a "just transition." Appalachia will face greater barriers in moving away from coal mining due to fewer alternatives from higher quality employment sectors. This raises a serious question for future scholars and policymakers: Will the region become a national sacrifice zone in the movement toward cleaner energy?

As the nation moves away from coal as an energy source, our findings for coal employment have implications for the limits and possibility of policies, but we stress several caveats. In the decades over which rural sociologists have analyzed mining, the U.S. economy as a whole has changed. In the post-2000 period, national employment growth overall has waned while jobs and livelihoods become increasingly precarious, particularly for the working class (Cherlin 2014; Kalleberg 2011). Insofar as coal mining today is related to higher income and lower poverty than in sectors like manufacturing, the coal industry obscures the fundamental damage done to communities in the past and adds barriers to progressive change. Moreover, we need to seriously acknowledge the limits of federal policy today. In previous eras when the federal government was more prone to spatial Keynesianism, that is, interest in reducing inequality across regions, currently, communities have to increasingly fend for themselves (Brenner 2004). Although some communities have employment gains from oil and natural gas drilling, whether oil and gas offer any long-term livelihood alternatives to coal is questionable. Further, our study centers on bringing together two rural sociological literatures to analyze coal employment. Employment is only one component of a just transition, which requires broad changes in the operation of capital and the state. In sum, any serious discussion of policy is complex and as this is not a policy study, the discussion of policy here is necessarily limited.[16]

Our findings speak to jobs and the role of the demand side of the labor market in influencing the quality and quantity of employment across the United States. In addition to macroeconomic policies targeted toward

[16] As coal employment continues to decline, policy studies will be an important avenue of future research to assess the national transition away from the industry and to evaluate community-development strategies of winning and losing regions.

producing an economy with widely shared growth (Hacker and Loewentheil 2012), we and others have argued that place-based policies are particularly needed to promote community well-being particularly in high-poverty regions such as Appalachia (Bartik 2001; Lobao and Kraybill 2009; Partridge and Rickman 2006; Ziliak 2012). Such policies are aimed at locally oriented business creation, strengthening public services, improving workforce education, and infrastructure development. These policies emphasize investing in places in addition to the important policies targeted to individual recipients such as means-tested social programs (Lobao et al. 2012). The intent of investing in places is to improve families' livelihoods by making work effort easier, increasing workers' bargaining power for good jobs, and improving local business quality. With improved labor force capacity and bargaining power, communities will have better ability to grow their local economies and set the course for future development. President Obama's promise zones directed to coal mining counties are an example of the place-based approach (Lowrey 2014).

At present, public policies of any type run into antigovernment critiques, with federal interventions more difficult to implement than in the past. Nevertheless, our findings serve to reiterate that a concerted approach is needed to improve the quality and quantity of employment across U.S. communities as the nation moves toward cleaner energy. This policy direction is particularly important for Appalachia, where structural disadvantages compound the movement away from coal mining.

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Appendix

Appendix Table 1. Spatial Regressions of the Poverty Rate across U.S. and Appalachian Counties (Standardized Coefficients)

	1990–2000		2000–2010	
	Total Poverty U.S.	Total Poverty ARC	Total Poverty U.S.	Total Poverty ARC
Local economic structure				
Share coal	0.019+	0.015	−0.025***	−0.055*
Share oil and gas	0.042***	−0.016	−0.033***	0.024
Share other mining	−0.005	−0.004	−0.012+	−0.015
Share manufacturing	0.028**	0.037	0.007	0.044
Share high-paying services	−0.045***	−0.036	−0.030**	−0.070*
Share education, health, social	0.017*	0.025	0.012	−0.007
Share low-paying services	−0.030***	0.014	0.006	0.034
Change in local economic structure				
Change coal	−0.007	−0.058*	−0.003	−0.034+
Change oil and gas	0.035***	−0.022	0.007	−0.008
Change other mining	−0.004	0.023	−0.010	−0.032+
Change manufacturing	−0.010	−0.047*	−0.032***	−0.060+
Change high-paying services	0.000	−0.029+	−0.017*	−0.061*
Change education, health, social	0.032***	0.046*	0.014*	−0.018
Change low-paying services	−0.017**	−0.016	0.016*	0.022
Population attributes and location				
Kilometers from MSA	0.048***	0.023	−0.016	0.066**
Log population	0.005	0.064**	0.092***	0.034
Percent foreign born	0.053***	0.080**	0.011	0.051
Percent college graduate	0.052***	0.008	−0.093***	−0.073+
Percent female-headed households	0.057***	−0.051+	0.099***	0.152***
Age ≤ 17	−0.014	0.025	−0.135***	−0.108**
Age > 65	−0.030**	−0.041+	−0.043***	−0.002
African American	0.047***	0.107***	0.023	−0.054
Non–African American	0.069***	−0.034*	0.049***	−0.034
Hispanic	−0.012	0.003	0.010	0.017
Employment/population ratio	−0.062***	−0.139***	−0.112***	−0.035
Poverty rate (lagged)	0.756***	0.790***	0.740***	0.767***
Intercept	5.717***	5.148	15.078***	11.715**
Lambda	0.072***	0.029	0.001	0.063
Rho	0.155***	0.134	0.286***	−0.105
Pseudo R2	0.899	0.930	0.895	0.878
N	3072	420	3072	420

Note. ARC = Appalachian Regional Commission. MSA = metropolitan statistical area. + $p < .10$, * $p < .05$, ** $p < .01$, *** $p < .001$.

Appendix Table 2. Spatial Regressions of Median Household Income across U.S. and Appalachian Counties (Standardized Coefficients).

	1990–2000		2000–2010	
	Median Household Income U.S.	Median Household Income ARC	Median Household Income U.S.	Median Household Income ARC
Local economic structure				
Share coal	−0.020*	−0.057*	0.029***	0.083***
Share oil and gas	−0.069***	−0.020	0.046***	0.014
Share other mining	0.007	−0.001	0.011*	0.007
Share manufacturing	−0.020*	−0.078**	−0.019*	−0.014
Share high-paying services	0.048***	0.039+	0.041***	0.058**
Share education, health, social	−0.018**	−0.031	−0.010+	0.010
Share low-paying services	0.018**	−0.032+	−0.010	0.000
Change in local economic structure				
Change coal	0.016+	0.052*	0.005	0.005
Change oil and gas	−0.026***	0.010	0.038***	0.012
Change other mining	0.016**	−0.005	0.011*	0.012
Change manufacturing	0.020**	0.047*	0.033***	0.038+
Change high-paying services	0.006	0.019	0.021***	0.034*
Change education, health, social	−0.027***	−0.036*	−0.006	0.005
Change low-paying services	0.009+	−0.014	−0.004	−0.012
Population attributes and location				
Kilometers from MSA	−0.050***	0.008	0.013	−0.056**
Log population	−0.035***	−0.071***	−0.048***	−0.029
Percent foreign born	−0.029***	−0.078***	−0.019*	−0.063+
Percent college graduate	0.025*	0.042	0.066***	0.109***
Percent female–eaded households	−0.048***	0.037	−0.073***	−0.029
Age ≤ 17	0.047***	−0.017	0.079***	0.034
Age > 65	−0.010	−0.017	−0.056***	−0.095***
African American	−0.041***	−0.094**	−0.036**	−0.094**
Non–African American	−0.022**	0.031*	−0.043***	−0.013
Hispanic	−0.013	0.023	−0.012	0.006
Employment/population ratio	0.004	0.096**	−0.038***	−0.063+
Median household income (lagged)	0.816***	0.784***	0.881***	0.915***
Intercept	1.683***	2.294***	1.645***	2.468***
Lambda	0.115***	0.094*	0.016	0.026
Rho	0.267***	0.262**	0.357***	0.226*
Pseudo R2	0.928	0.943	0.941	0.938
N	3072	420	3072	420

Note: ARC = Appalachian Regional Commission. MSA = metropolitan statistical area. + $p < .10$, * $p < .05$, ** $p < .01$, *** $p < .001$.

Appendix Table 3. Spatial Regressions of the Unemployment Rate across U.S. and Appalachian Counties (Standardized Coefficients).

	1990–2000		2000–2010	
	Unemployment Rate U.S.	Unemployment Rate ARC	Unemployment Rate U.S.	Unemployment Rate ARC
Local economic structure				
Share coal	0.003	0.010	−0.028**	−0.080*
Share oil and gas	0.010	0.073*	−0.026*	0.036
Share other mining	−0.018	−0.014	−0.012	0.052+
Share manufacturing	−0.022	−0.023	0.077***	0.140**
Share high-paying services	−0.009	−0.004	0.014	0.014
Share education, health, social	−0.033**	−0.027	−0.016+	−0.004
Share low-paying services	−0.013	−0.021	0.052***	0.017
Change in local economic structure				
Change coal	−0.030+	−0.085+	−0.032***	−0.105***
Change oil and gas	−0.009	0.026	−0.043***	−0.121*
Change other mining	−0.038***	0.044	−0.043***	−0.060*
Change manufacturing	−0.081***	−0.195***	−0.122***	−0.225***
Change high-paying services	−0.021*	−0.041	−0.018*	0.030
Change education, health, social	0.003	0.012	−0.016+	0.001
Change low-paying services	−0.039***	−0.117***	−0.015+	0.007
Population attributes and location				
Kilometers from MSA	0.028*	−0.003	−0.076***	0.025
Log population	−0.038*	0.017	0.015	−0.041
Percent foreign born	0.075***	0.036	0.001	−0.052
Percent college graduate	−0.054**	−0.127*	−0.113***	−0.185**
Percent female-headed households	0.067***	0.127*	0.041*	0.037
Age ≤ 17	0.029	0.011	0.033*	0.082
Age > 65	0.042**	0.079+	−0.008	−0.043
African American	0.104***	0.024	0.067***	0.148*
Non–African American	0.064***	0.081**	−0.056***	0.041
Hispanic	0.037*	−0.002	−0.011	0.052

Appendix Table 3. ***Continued***

	1990–2000		2000–2010	
	Unemployment Rate U.S.	Unemployment Rate ARC	Unemployment Rate U.S.	Unemployment Rate ARC
Employment/population ratio	−0.173***	−0.206**	−0.049**	−0.133*
Unemployment rate (lagged)	0.458***	0.311***	0.487***	0.390***
Intercept	3.700***	3.147*	4.941***	5.670*
Lambda	0.158***	0.259+	0.044	0.200*
Rho	0.298***	−0.057	0.508***	−0.032
Pseudo R2	0.789	0.763	0.803	0.702
N	3072	420	3072	420

Note: ARC = Appalachian Regional Commission. MSA = metropolitan statistical area.
+ $p < .10$, * $p < .05$, ** $p < .01$, *** $p < .001$.