Journal of Rural and Community Development

Can Unconventional Oil and Gas Reduce the Rural Mortality Penalty? A Study of U.S. Counties

Author: Adam P. Mayer

Can Unconventional Oil and Gas Reduce the Rural Mortality Penalty?
A Study of U.S. Counties

Adam P. Mayer
Colorado State University
Fort Collins, Colorado, United States
adampetermayer@gmail.com

Abstract

Rural places in the United States increasingly face seemingly intractable problems—perhaps the most severe of these is the 'rural mortality penalty' wherein rural places have higher mortality rates than suburban and urban places. The boom in unconventional oil and gas production in the mid-2000s brought with it the promise of rural renewal, and the potential to address rural America's long-standing development challenges. In this analysis, we ask how the oil and gas boom has impacted the rural mortality penalty. Our results imply that oil and gas development will not improve or damage mortality rates. Implications for rural populations are discussed.

Keywords: Rural mortality penalty; oil and gas development; multilevel model

---

1.0 Introduction

Recent research finds an increasing macro-level divergence between American rural and urban mortality rates—beginning in the 1980s, rural populations experienced higher mortality rates than their urban counterparts (Cosby et al., 2008; Cossman, James, Cosby, & Cossman, 2010; James, 2014). There was a non-trivial urban mortality penalty between 1800s–1900s and a period with little difference between urban and rural mortality rates from the 1940s to 1980s (Clifford & Brannon, 1985; Haines, 2001; Higgs & Booth, 1979; Murray et al., 2006). Currently, rural places tend to have persistently higher mortality rates. For instance, Cosby et al. (2019) use 47 years of data (1970–2016) and find that the rural mortality penalty has grown over time, such that rural places experience 134 excess deaths per 100,000 when compared to urban places. Further, the rural mortality penalty has grown some 75% between 2004 and 2016.

There are many correlates of rural mortality, including poverty (Litaker, Koroukian, & Love, 2005), female-headed households (Lichter & McLaughlin, 1995) and age composition (Clifford, Miller, & Stokes, 1986; Miller, Stokes, & Clifford, 1987). Rural places also experience high rates of chronic illness (Ezzati, Friedman, Kulkarni, & Murray, 2008; Murray et al. 2006) and often lack access to comprehensive health care services (Buchanon et al., 2006; Chan, Hart, & Goodman, 2006; Litaker, Koroukian, & Love, 2005), as evident in physician and hospital shortages (Kaufman et al., 2016; Li, Schneider, & Ward, 2009; Ricketts, 1999). Rural areas also suffer from other seemingly intractable problems, such as human capital flight and the loss of working age population (Carr & Kefalas, 2009; Mayer, Malin, & Olson-Hazboun 2018).

The mid-2000s saw a drastic increase in domestic, on-shore oil and gas production made possible by the convergence of unconventional drilling technologies like hydraulic fracturing (i.e., 'fracking'), directional drilling, and underground mapping. Unconventional oil and gas extraction (UOGE) is widely touted as a boon for rural places, potentially addressing long-run problems of anemic economic growth, population loss, and limited health services. On the other hand, the 'boomtown' and resource curse traditions suggest that communities that host extractive industries will bear more costs than benefits in the long run.

In this paper, we ask if UOGE can improve rural mortality in host communities. More specifically, we test whether oil and gas production improves all-age mortality and age specific mortality from the 2000-2016 period using a large sample of U.S. counties and multi-level modelling techniques with a range of socio-demographic control variables. This impact of UOGE on mortality is crucially important, as rising mortality is one of many structural problems facing rural America. Yet, prior research suggests that UOGE likely provides job growth and increases income in rural places but will not solve seemingly intractable structural problems like poverty and out-migration (Mayer, Olson-Hazboun, & Malin 2018; Mayer, Malin and Olson-Hazboun 2018). In the next section, we review the relevant literature on extractive industries, local development, and community well-being.

2.0 Impacts of Extractive Industries

2.1 Boomtowns and the Natural Resource Curse

Social scientists have long documented the impact of extractive industries, such as various forms of mineral extraction, oil, gas, coal or other mining, on host communities and nations. Much of this research describes an apparent 'paradox of plenty', wherein regions that are blessed with generous resource endowments often perform worse on a range of economic and social fronts than those who have scant natural resources.

A long tradition in rural sociology began with Kohrs' (1974) conference paper. Kohrs argued that the small town of Gillette, Wyoming was beleaguered by social ills like increased crime, prostitution, and loss of community cohesion wrought by a mining boom. Subsequent research conducted in other locales also described similar effects, including stresses on infrastructure and public services (Bacigalupi & Freudenberg, 1983; Cortese & Jones, 1977; Freudenburg, Bacigalupi,, & Landoll-Young, 1982; Krannich and Grieder, 1984). However, scholars quickly recognized that the early 'boomtown' literature also suffered from various methodological short-comings and began to chronicle patterns of boom-bust-recovery cycles (Brown, Dorins, & Krannich, 2009; Wilkinson, Thompson, Reynolds, & Ostresh, 1982).

The contemporary boom in oil and natural gas production re-invigorated interest in the classic boomtown model. Jacquet and Kay (2014) argue that the classic model may not aptly describe the current boom. The authors describe how new technologies have brought oil and natural gas extraction into peri-urban and suburban spaces rendering the boomtown model's assumption of spatial isolation potentially inapplicable. They also point out that oil and gas wells are unlikely to experience sudden booms and dramatic busts, but rather a series of boom and bust cycles. Further, much current development occurs on private land in diffuse locations, rather than a single large facility on public land.

Another research tradition, mostly rooted in international political science and economics, identifies a 'natural resource curse' wherein nations that have significant natural resource endowments—particularly in the form of extractive resources— tend to have higher poverty rates, slower economic development, and generally substandard performance on many social and economic indicators (Frankel, 2010; Sachs & Warner, 2001; Sala-i-Martin & Subramanian, 2013). The specific mechanisms that cause the resource curse are varied but include political corruption and crowding-out of non-extractive industries (Bulte & Damania, 2008; Mehlum, Moene & Torvik, 2006; Papyrakis & Gerlaugh, 2004).

The resource curse has occasionally been observed sub-nationally in the United States. For instance, Corey and McMahon (2009) use the total share of agriculture, forestry, fishing, and mining as a percentage of the economy of U.S. states for their indicator of natural resource dependence. They find that natural resource dependence coupled with poor institutional quality is associated with slower economic growth. James and Aadland (2011) use a similar indicator of dependence and report that it is associated with slower growth in per-capita income at the state level. Current evidence suggests that UOGE is not creating some of the typical effects observed in the resource curse literature such as slower economic growth or reduced household income (Brown, 2014; Weber, 2014).

2.2 Impacts of Unconventional Oil and Gas

Recent research documents the impact of oil and gas production on communities in the United States in light of the mid-2000s uptick in production. The magnitude of these impacts varies across scales but given current evidence it is not clear that UOGE is a net positive for host communities across all domains.

As noted above, rural places continue to struggle with adequate health services and higher mortality rates. Despite these long-run health challenges, changes in the energy sector may hold great promise for rural renewal. The boom in unconventional oil and gas extraction (UOGE) has been associated with economic development in rural places, ranging from job creation (Komarek, 2016; Maniloff & Mastromonaco, 2017), increased earnings (Mayer, Malin and Olson-Hazboun 2018; Weber, 2012; Weinstein, Partridge, & Tsvetkova, 2018), critically important tax revenue (Newell & Raimi, 2018a, 2018b; Mayer 2018a), and windfall profits for land-owners that lease to the industry (Bugden & Stedman, 2019). The economic infusion brought by UOGE could address many of the underlying structural causes of the rural mortality penalty, yet current evidence also suggests that UOGE will not halt rural human capital loss (Mayer, Malin and Olson-Hazboun 2018; Rickman, Wang, & Winters, 2017), reduce rural poverty (Mayer, Olson-Hazboun and Malin 2018) or improve health services in host counties (Mayer 2018b).

There are also other reasons to be cautious about UOGE's positive impacts on communities as it may have negative impacts on public health (Adgate, Goldstein, & McKenzie, 2014). Residents of communities that host UOGE have raised concerns about noise, dust, and air and water pollution (Jacquet, 2012; Jacquet & Stedman, 2013; Ladd, 2014; Schafft, Borlu, & Glenna, 2013) and decibel levels near drilling sites are loud enough to damage health (Blair, Brindley, Dinkeloo, McKenzie, & Adgate, 2018). Children and infants are especially vulnerable, with indications that UOGE may increase the likelihood of certain cancers (e.g., Helm, Zhong, MP, & Joseph, 2017; McKenzie, Witter, Newman, & Adgate, 2012; McKenzie et al., 2017), congenital heart defects (McKenzie et al., 2014), and low

birth weight and pre-term birth (Hill, 2018). In some instances, UOGE creates short-term in-migration of transient workers—this can generate impacts ranging from increased crime (James & Smith, 2017) to greater prevalence of sexually transmitted disease (Deziel, Humeau, Elliott, Warren, & Niccolai, 2018; Komarek & Cseh, 2017), to heightened stress and emotional distress from rapid community change (Casey, Wilcox, Hirsch, Pollak, & Schwartz, 2018; Fisher, Mayer, Vollet, Hill, & Haynes, 2018; Hirsch et al. 2017;) and the feeling that UOGE reduces a community's ability to decide its own future (Malin, 2014; Perry, 2012). In general, UOGE is associated with a range of quality of life impacts (Fernando & Cooley, 2016).

Extractive industries often have a gendered dimension. Bell and Braun (2010) describes how resistance to coal mining in Appalachia is largely driven by women, and studies conducted in diverse settings suggest that extractive industries are often culturally associated with masculinity (Bell and Braun 2010; O'Shaugnessy & Krogman, 2011; Quam-Wickham, 1999). An important exception is Smith's (2014) study of a Wyoming coal mine, who observed men and women working side-by-side. Still, some of the psychological impacts of UOGE could be concentrated among men. Filteau (2015; 2016) shows that men in communities that host UOGE often feel a sense of emasculation because of the high wages of transient UOGE workers. This crisis of local masculinity, as well as the general gendered dimension of extractive industries, suggests that UOGE could have differential effects on men, especially those who are of working age.

Women also have gendered experiences with UOGE. Evidence from Texas suggests than men are more likely to be directly employed by the oil and gas industry, although women also take jobs in the industry during a boom and benefit indirectly from spill-over effects (Cai, Maguire, & Winters, 2019). McHenry-Sorber et al. (2018), relying on qualitative data, argue that UOGE creates a gendered opportunity structure in which the most desirable jobs are occupied by men and women are relegated to low-wage, service sector jobs that support the extractive sector—examples include employment in hotels and restaurants. This is despite efforts by the industry to promote gender equality (Williams, Kilanski, & Muller , 2014). Women's concerns with UOGE may be taken less seriously (McHenry, 2017) and crime or fears of crime created by an oil and gas boom have a clear gendered dimension (O'Connor, 2015; Pippert & Zimmer Schneider, 2018). Hence, oil and gas development appears to be gendered in important ways. In the next section, we describe the data and analysis.

3.0 Data, Measures and Methods

3.1 Outcome Measures

We accessed mortality data from the Center for Disease Control's compressed mortality file for the years 2000–2016—we use this year range because it encompasses a period of time wherein oil and gas production increased markedly. Our first dependent variable is an all-cause mortality rate per 100,000 county residents for all ages and genders. Following Filteau's work on rural masculinity (2015; 2016), other research on the gendered aspects of extractive industries (e.g., Bell & Braun, 2010) and epidemiological studies on the rural mortality crisis (Cosby et al. 2008), we disaggregate mortality rates by both age and gender for additional dependent variables. The first disaggregated variable is a measure of the all-cause mortality rate for working age males (15–64 years old) and the last is an indicator of

all-cause mortality rate for working age females (15–64 years old). In Figures 1 through 3, we map these data. Generally, mortality rates are highest in rural places of the southern U.S. In addition, because of data limitations, age and sex-specific mortality rates cannot be calculated for several Great Plains and Mountain West counties.

Figure 1. Average all-age, all-cause mortality per 100,000 residents in U.S. Counties, 2000–2016. Source: Center for Disease Control
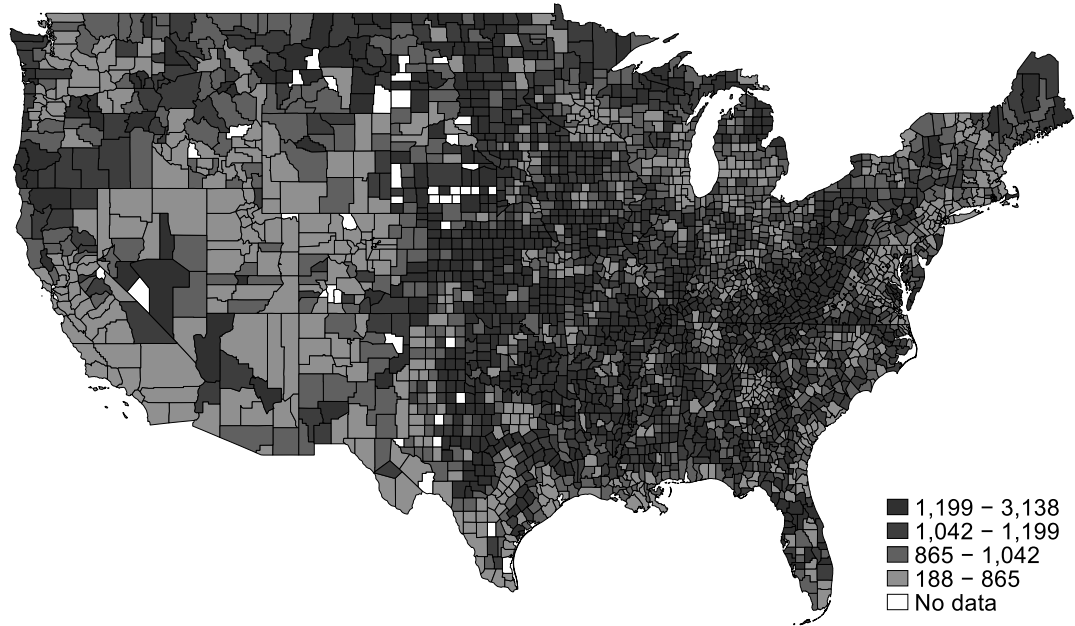

1,199 − 3,138
1,042 − 1,199
865 − 1,042
188 − 865
No data

Figure 2. Average all-cause mortality per 100,000 residents in U.S. Counties, 2000–2016, females aged 15–64. Source: Center for Disease Control
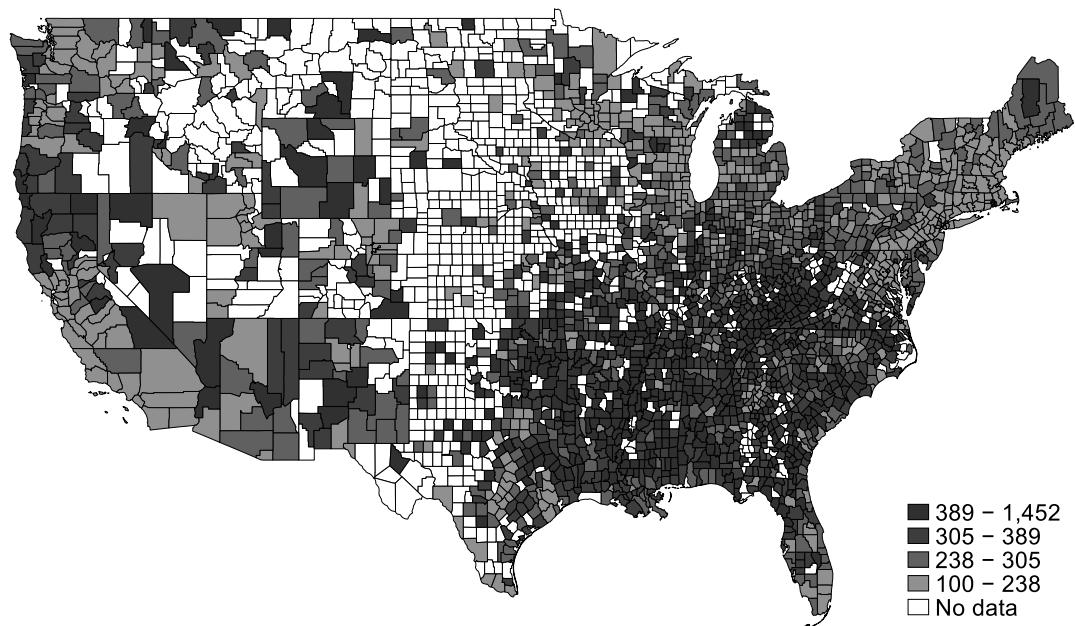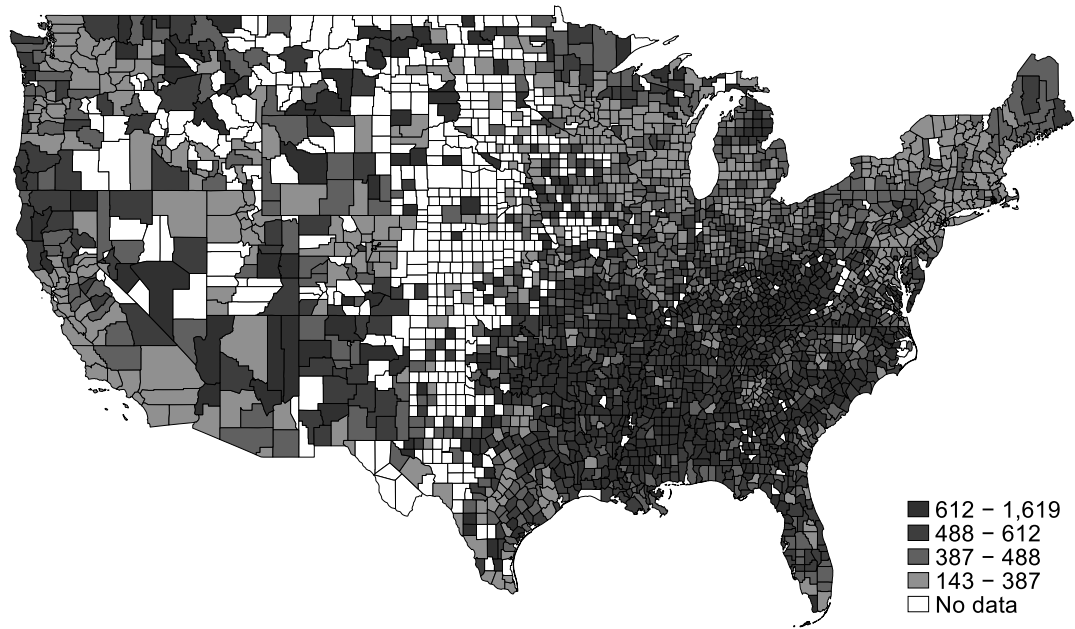

389 − 1,452
305 − 389
238 − 305
100 − 238
No data

Figure 3. Average all-cause mortality per 100,000 residents in U.S. Counties, 2000–2016, males aged 15–64. Source: Center for Disease Control

612 − 1,619
488 − 612
387 − 488
143 − 387
No data

3.2 Predictor Variables – Oil and Gas Wells

There is no federal entity that comprehensively tracks oil and gas production at the well level, or at smaller spatial scales such as counties. In this application, we use county-level counts of active wells derived from data provided by Enverus, formerly known as Drillinginfo. To develop these indicators, we used the spud date and completion date of each well to define active and inactive wells (Hill, 2018). Classifying wells presented unique challenges. Enverus lists the 'type' of well for each well in their database—wells can variously be classified as coal bed methane, saltwater injection, oil production, or gas production. In any given year, roughly 3% of wells are classified as both oil and gas. To avoid dropping this data our indicator of oil and gas production includes both oil and gas wells, as opposed to differentiating between oil and gas as has been done in some studies (e.g.,Mayer & Olson-Hazboun 2019). We assigned wells to counties using the *geoinpoly* command in Stata 15/ IC (Picard, 2015).

3.3 Control Variables

As noted above, much research ties local mortality rates to economic conditions, and we include a suite of variables to control for the state of a county's economy. These include county-level median income, poverty rates and per capita income using data obtained from the Bureau of Economic Analysis (2018). To capture country rurality, we use the United States Department of Agriculture's rural-urban continuum code (USDA Economic Research Service, 2018), a commonly used variable in many analyses (e.g., Mayer, Olson-Hazboun, & Malin 2018; Singh & Siahpush, 2002). We calculated a labor force participation rate per 1,000 county residents using data from the Bureau of Labor Statistics (2018) and the U.S. Census Bureau (2018).

Population in thousands was also provided by the U.S. Census. Descriptive statistics for the control variables are provided in Table 1.[1]

Table 1: *Descriptive Statistics*

Variable	Mean	SD	Source
Rural-Urban Code	4.864	2.680	USDA ERS
Population (000s)	97.730	312.349	U.S. Census
Pop. Density (000/ sq mile)	0.907	1.217	U.S. Census
Labor participation (per 1000)	482.650	64.433	BLS/ U.S. Census
Poverty (%)	15.158	6.292	BEA
Per Capita Income	32501.870	10420.770	BEA
Median income	38821.400	15805.590	BEA

3.4 Analytic Strategy

Given the nested nature of our data—our observations are nested within counties and within years—we use multi-level regression models wherein we allow intercepts to vary randomly across counties. We implement the between- and within- random effects approach described by Bell and Jones (2015). The authors explain that standard multi-level modelling strategies estimate regression coefficients that are the sum of both a within effect and a between effect. The within effect can be understood as how much a one-unit increase in a predictor variable changes the outcome variable *within* a given unit of analysis, while the between effect is the cross-sectional effect of changes in the predictor. In our case, the within effect captures how much an additional oil or gas well changes mortality rates within a county, while the between effect allow us to understand if counties that have more oil and gas wells tend to have higher or lower mortality rates than those that have less oil and gas production. Put another way, the within-effects capture changes within counties, while the between-effects allow us to compare across counties. The estimation of the between effects is accomplished by including a county-level average for relevant predictor variables. In our application, we include county level averages for active oil and gas wells to capture the between effects. All models include unreported state-year variables.

We suspect that endogeneity problems may plague our efforts to isolate the effect of oil and gas development. Some counties might aggressively pursue oil and gas production because of their poor economies, and, as noted earlier, oil and gas production are also associated with job and wage growth. Thus, oil and gas production could impact mortality rates via economic variables and have little direct effect. There are multiple ways to correct for these endogeneity problems, such as instrumental variables or propensity score matching methods.

Here we implement a technique call entropy balancing, first developed by Hainmueller (2012). Entropy balancing shares some similarities with propensity score matching in that it is a causal inference technique for observational data that

---

[1] Our analysis does not control for county-level racial characteristics or access to health services at the county level because data does not exist for the entire period under analysis.

aims to create covariate balance (e.g., equivalence of means) between treatment and control groups, thereby approximating a situation akin to random assignment of the treatment condition (Zhoa & Percival, 2017). However, entropy balancing has key advantages over other techniques. In particular, it employs an algorithm that generates balancing weights, effectively eliminating many of the arbitrary choices that occur in propensity score matching (Caliendo & Kopeining, 2008; Smith & Todd, 2001). Further, unlike instrumental variable methods, entropy balancing relies on few assumptions. Entropy balancing is therefore a simple, intuitive and easy to implement alternative method to others that might address endogeneity issues. Perhaps for this reason, the technique has been increasingly widely deployed across multiple disciplines since its introduction (e.g. Mayer 2017; Mayer, Malin, & Olson-Hazboun 2018; Geminis & Rosema, 2014; Marcus, 2013; Truex, 2014).

In our application, we used the *ebalance* package in Stata 15/IC (Hainmueller & Xu, 2013) to generate balancing weights for our control variables—(a) the USDA's rural-urban code, (b) population in thousands, (c) population density, (d) labor force participation, (e) poverty, (f) per capita income, and (g) median income. These variables were entered in the entropy balancing algorithm, which created sample weights to balance them on their means between counties that did not have any oil or gas production and those with oil or gas production. When the weights are applied to the models described below, this simulates a scenario wherein oil or gas production was randomly assigned to counties with respect to the control variables. In this way, the estimates of oil and gas production shown below are not polluted with endogeneity, at least in terms of county-level economic characteristics.

We estimate five unique models for each outcome. The logic of this approach is that entropy balancing might match counties from very different regions of the country if they share similar economic characteristics. That is, the balancing weight for a New Hampshire county might be very similar for a Montana county if they are similar in terms of poverty rates, median income, or other variables. To circumvent this problem, we entropy balance within U.S. census regions (e.g., South, Northeast, Midwest and West) and re-estimate our models for these respective regions. Thus, each outcome variable receives a total of five models. We also focus our discussion on the effects of the oil and gas production variables, as opposed to narratively describing every coefficient generated by our models.

3.5 Modelling Results

Table 2 provides results from the multi-level model for all-age, all-cause mortality for both sexes. For all U.S. counties, mortality rates increase as the number of active oil and gas wells increases. Yet the between effect of oil and gas wells—captured by our indicator of average wells—implies that counties with oil and gas production tend to have lower mortality rates than counties without oil and gas production. Put another way, the within-effect suggests that more wells will increase mortality rates within producing counties, but the between-effect suggests that counties with active production tend towards lower mortality rates. These findings persist for the southern region of the U.S. but do not retain their statistical significance in any other region, suggesting regional differences in how oil and gas development influences all-cause, all-age mortality. Consistent with prior research, economic variables and rurality are important predictors of county mortality rates.

Table 2: *Multilevel Regression Models for All-cause Mortality Rates, All Ages*

	All U.S. b/(se)	South b/(se)	Northeast b/(se)	Midwest b/(se)	West b/(se)
Active oil and gas wells	0.008*** (0.00)	0.013** (0.00)	-0.006 (0.00)	0.029 (0.02)	0.004 (0.00)
Average oil and gas wells	-0.032*** (-0.01)	0.062** (-0.01)	0.058* (-0.03)	0.003 (-0.04)	-0.013 (-0.01)
Population (000s)	-0.054*** (-0.02)	-0.110*** (-0.03)	-0.089** (-0.03)	-0.057** (-0.02)	-0.017** (-0.01)
Population Density (000/ sq mile)	-16.489** (-5.56)	-124.848*** (-14.97)	10.037 (-10.62)	0.184 (-12.28)	-10.484* (-5.2)
Labor Force Participation ratio	-0.065 (0.04)	0.012 (0.05)	-0.14 (0.22)	-0.076 (0.08)	-0.352*** (0.09)
Poverty (%)	-2.005*** (0.48)	-1.012 (0.6)	-8.436*** (2)	-4.231*** (1.2)	-2.547 (1.33)
Median Income ($)	-0.009*** (0.00)	-0.007*** (0.00)	-0.007*** (0.00)	-0.014*** (0.00)	-0.009*** (0.00)
Per Capita Income	0.001 (0.00)	0 (0.00)	0.001 (0.00)	0.002** (0.00)	0.002* (0.00)
Variance(intercepts)	26936.22	26154.709	13812.297	20783.741	38599.561
N	47937	21888	3683	15422	6944
AIC	356594.1	207281.304	21063.036	77564.323	47326.119
BIC	357305	207680.989	21330.13	77900.64	47641.018

Note: Models include state and year fixed effects and the USDA-ERS Urban-Rural Continuum code

Note: Models use entropy balancing weights
* for p<0.05, ** for p<0.01, * for p<.001

Table 3 displays modelling results for the mortality rate for females aged 15–64. In this series of models, the within-effect of oil and gas production only reaches statistical significance in two models, and the between-effect never reaches this threshold. These effects imply that oil and gas production has little to no influence on mortality rates for working-age females at the county-level. Similar to the previous suite of models, county economic conditions and a county's place along the urban-rural continuum appear to be consistent predictors of mortality rates.

Table 3: *Multilevel Regression Models for All-cause Mortality Rates, Females Age 15–64*

	All U.S. b/se	South b/se	Northeast b/se	Midwest b/se	West b/se
Active oil and gas wells	-0.000	-0.006**	-0.006	0.007	0.001*
	(0.00)	(0.00)	(0.00)	(0.01)	(0.00)
Average oil and gas wells	0.001	0.014	0.014*	0.008	-0.001
	(0.00)	(0.01)	(0.01)	(0.04)	(0.00)
Population (000s)	-0.030***	-0.067**	-0.007	-0.009	-0.016*
	(0.01)	(0.02)	(0.01)	(0.01)	(0.01)
Population Density (000/ sq mile)	-3.460	-70.638***	1.473	-13.992	1.565
	(1.97)	(9.44)	(2.91)	(7.73)	(1.89)
Labor Force Participation ratio	-0.155***	-0.095**	-0.217*	-0.280***	-0.154**
	(0.02)	(0.03)	(0.11)	(0.05)	(0.06)
Poverty (%)	0.116	0.190	-2.095*	-0.059	0.427
	(0.33)	(0.42)	(0.88)	(0.65)	(0.78)
Median Income ($)	-0.003***	-0.003***	-0.003***	-0.004***	-0.002***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Per Capita Income	0.000	0.000	0.000	-0.001*	0.000
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Variance(Intercepts)	3424.600	4470.482	577.943	1603.522	3203.618
N	29389.000	15013.000	3386.000	7580.000	3410.000
AIC	183127.732	122370.893	16485.999	28868.661	18623.022
BIC	183799.090	122751.727	16749.477	29173.725	18905.208

Note: Models include state-year fixed effects and the USDA-ERS Urban-Rural Continuum code.
Note: Models use entropy balancing weights
* for p<0.05, ** for p<0.01, * for p<.001

We provide the final series of modelling results in Table 4 for working age (15–64 years old) mortality rates for males. In both the aggregated model and the sub-regional models, neither the within-effect nor the between-effect of oil and gas production breaches statistical significance. This finding implies that oil and gas production will not improve or damage mortality rates within counties or between counties for working-age males. Consistent with earlier models, socio-demographic factors and country rurality are robust predictors across model specifications, with higher mortality rates in rural and economically disadvantaged settings.

Table 4: *Multilevel Regression Models for All-cause Mortality Rates, Males Age 15–64*

	All U.S. b/(se)	South b/(se)	Northeast b/(se)	Midwest b/(se)	West b/(se)
Active Oil and Gas Wells	-0.001 (0.000)	-0.006* (0.000)	-0.002 (0.000)	0.004 (0.01)	0 (0.000)
Average Oil and Gas Wells	-0.001 (0.000)	0.005 (0.01)	0.000 (0.01)	-0.034 (0.030)	0.003 (0.000)
Population (000s)	-0.041*** (0.01)	-0.083*** (0.02)	-0.009 (0.02)	-0.011 (0.01)	-0.030* (0.01)
Population Density (000/ sq mile)	-2.954 (2.58)	-88.603*** (12.48)	-1.258 (5.01)	-9.694 (8.76)	0.186 (3.00)
Labor Force Participation Ratio	-0.142*** (0.03)	-0.114** (0.04)	-0.246 (0.19)	-0.233*** (0.06)	-0.152 (0.08)
Poverty (%)	-0.432 (0.41)	-1.146* (0.50)	-1.823 (1.21)	-0.115 (0.95)	2.111 (1.12)
Median Income ($)	-0.005*** (0.000)	-0.005*** (0.000)	-0.005*** (0.000)	-0.007*** (0.000)	-0.003*** (0.000)
Per Capita Income	0.001*** (0.000)	0.001*** (0.000)	0.001 (0.000)	0.001 (0.000)	0.001 (0.000)
Variance (Intercepts)	9366.265	10145.83	2313.026	4934.126	13899.06
N	36937	18753	3543	10267	4374
AIC	252728.235	167383.8	19006.51	42141.62	26921.41
BIC	253418.11	167775.7	19271.94	42460.04	27215.05

Note: Models include state-year fixed effects and the USDA-ERS urban-rural continuum code

Note: Models use entropy balancing weights

* for p<0.05, ** for p<0.01, * for p<.001

3.6 Robustness Checks

The first robustness check that we performed used the *konfound* method to quantify how robust our inferences are to omitted variables (Frank, Maroulis, Duong, & Kelcey, 2013; Xu et al. 2019). Briefly, the konfound method estimates the magnitude of the relationship between the outcome and a potential omitted variable that would be necessary to render a statistically significant result non-significant expressed as a Pearson correlation. A more conventional method of understanding the robustness of a finding is to implement additional models with different specifications (e.g., introducing new control variables) or using different estimation techniques. The konfound method is advantageous because it provides a simple, easy to grasp estimate of the robustness of an effect. We provide these correlations

for the statistically significant (e.g., alpha<.05) relationships we found the series of models reported above (see table 5).

Table 5: *Results of konfound Analysis*

	All U.S.	South	Northeast	Midwest	West
All Ages and Sexes					
Active Oil and Gas Wells	0.167				
Average Oil and Gas Wells	0.37				
Females					
Active Oil and Gas Wells		0.081			
Average Oil and Gas Wells					
Males					
Active Oil and Gas Wells		0.072			
Average Oil and Gas Wells					

Note: Table reports Pearson correlation between omitted variable and outcome to invalidate the inference at alpha=.05

Both the between- and within- effect of oil and gas production was statistically significant for mortality rates for all ages in the model that used data for all U.S. counties (Table 2, model 1). However, the konfound analysis indicates that these results are not especially robust to omitted variable bias—an omitted predictor would only need a modest correlation to invalidate either the within- effect, while the between-effect is comparatively more robust. Similarly, the within- effect of oil and gas production was statistically significant for working age females in the south (Table 3, Model 2). Yet a potential omitted variable would only need a very modest correlation with the outcome to render the effect non-significant. Finally, the other significant effect was the within- effect for males in the southern region of the U.S. This inference appears to be more robust as an omitted variable would have to be correlated at 0.072 with the outcome to make this effect non-significant at alpha=.05. Thus, most of the statistically significant findings could be invalidated with a different model specification, imply that the relationship between UOGE and mortality rates is likely null.

We conducted additional analyses to determine if our null results would hold under alternative specifications. The oil and gas well data is highly skewed, and our modest to null findings may be the result of the unusual distribution of these variables. Accordingly, we log-transformed both the oil and gas production data and found nearly identical to those reported in our multilevel regressions—that is, oil and gas wells did not seem to influence mortality rates. To further address the skewed nature of each variable, we took our original indicators of within-county oil and gas production and converted them to categorical variables with three categories at no, median, and high oil and gas production. We swapped this variable for the

untransformed oil and gas well variables used in our models, but again the effect of oil and gas production was negligible.

Given that prior research has shown that the effect of UOGE varies across places (e.g., Munasib & Rickman, 2015), we checked if UOGE had differential effects on rural host communities than those that were more metropolitan. We implemented two techniques to do so. First, we re-estimated all models with interaction terms between within-county oil and gas well variables and the USDA's rural-urban continuum code. This resulting interaction term never reached statistical significance and was small in practical terms, implying that the rurality of a county does not condition the effect of UOGE on mortality. As a further robustness check, we eschewed the interaction term and instead excluded the most metropolitan counties (i.e., those with a Rural-Urban score equal to 1). Again, both the within- and between- effects of oil and gas wells were miniscule. These sensitivity checks imply that our results are not a function of the unusual distribution of oil and gas production as the relationship between UOGE and mortality seems to hold with alternative specifications and across different places. Full results are available from the authors.

4.0 Discussion and Conclusion

The purpose of this paper was to understand if oil and gas production could improve mortality in rural places as prior research has documented an increasing 'rural mortality penalty' wherein rural places experience higher mortality rates than their urban counterparts. The boom in oil and gas production wrought by new technologies holds much promise to reverse the long-run problems of rural places. Yet research has suggested the host communities experience a complex array of positive benefits and negative impacts from oil and gas production (e.g., Weber, 2012; Weinstein, Partridge & Tsvetkova, 2018). We used the within- and between-multilevel modelling strategy coupled with entropy balancing to understand how oil and natural gas production impacts mortality rates. Following research on the gendered nature and impacts of extractive industries, we expected that the impact of UOGE might be stronger on men than women.

Consistent with much prior research, a host of economic factors are the bedrock of mortality rates. Prior research has pointed to some economic benefits for communities that host UOGE (e.g., Newell & Raimi, 2018a; Weber, 2012), yet also suggests that it will not address the deeper challenges like persistent poverty and human capital flight facing rural places (Mayer, Olson-Hazboun, & Malin 2018; Mayer, Malin, & Olson-Hazboun 2018). Our models imply that counties that host UOGE are not consistently better or worse in terms of mortality rates, nor will increased UOGE improve or reduce mortality in host counties. Put another way, our within-county results suggest that UOGE will not likely improve or damage mortality rates in host counties. Per the between- county results, host counties do not appear to do better or worse than counties without oil and gas production.

We also suspected that the impact of UOGE was gendered, wherein UOGE would increase mortality rates for men more powerfully than for women. However, our models don't support this hypothesis—in general, UOGE appears to have little to no effect on mortality rates for any age or any gender.

These results reveal several important implications. UOGE has been touted as a potential economic savior for America's struggling rural places and seemingly

intractable structural problems such as persistent poverty, poor health services, and increasing mortality. Research shows that UOGE increases earnings and leads to some job growth in rural places (e.g., Munasib & Rickman, 2015; Mayer, Olson-Hazboun, & Malin 2018). Importantly, UOGE does not seem to improve mortality rates, suggesting that UOGE cannot address this unique problem. This raises several questions of justice and fairness, as host communities do not seem to retain all the potential benefits of UOGE.

As with all studies, ours has several limitations. First, the mortality rate data is not entirely comprehensive, as age and sex-specific mortality rates could not be calculated for sparsely populated counties in western states like Wyoming. We suggest that our results may not fully generalize to these regions, given the lack of data. This piece also points to future research needs. Future studies could investigate if the effect of UOGE varies across time and place—that is, does UOGE impact some places differently? Other sources of data, such as hospital admissions records, could also shed light on the health and well-being implications of UOGE. Further, we know very little about what kinds of policy regimes might allow host communities to capture more local benefits from oil and gas production, particularly benefits that might address the long-run structural inequalities facing rural America. Addressing this question is an important task.

References

Adgate, J. L., Goldstein, B. D., & McKenzie, L. M. (2014). Potential public health hazards, exposures and health effects from unconventional natural gas development. *Environmental Science & Technology, 48*(15), 8307–8320. https://doi.org/10.1021/es404621d

Bacigalupi, L. M., & Freudenberg, W. R. (June, 1983). Increased mental health caseloads in an energy boomtown. *Administration in Mental Health, 10*(4), 306–322.

Bell, A., & Jones, K. (2015). Explaining fixed effects: Random effects modeling of time-series cross-sectional and panel data. *Political Science Research and Methods, 3*(1), 133–153. https://doi.org/10.1017/psrm.2014.7

Bell, S. E., & Braun, Y. A. (2010). Coal, identity, and the gendering of environmental justice activism in central Appalachia. *Gender & Society, 24*(6), 794–813. doi:10.1177/0891243210387277

Blair, B. D., Brindley, S., Dinkeloo, E., McKenzie, L. M., & Adgate, J. L. (2018). Residential noise from nearby oil and gas well construction and drilling. *Journal of Exposure Science & Environmental Epidemiology, 28*(6), 538–547. https://doi.org/10.1038/s41370-018-0039-8

Brown, J. P. (2014). Production of natural gas from shale in local economies: A resource blessing or curse? *Economic Review - Federal Reserve Bank of Kansas City, 5*.

Brown, R. B., Dorins, S. F., & Krannich, R. S. (2009). The boom-bust-recovery cycle: Dynamics of change in community satisfaction and social integration in Delta, Utah. *Rural Sociology, 70*(1), 28–49. https://doi.org/10.1526/003601105329467

Buchanan, R. J., Stuifbergen, A., Chakravorty, B. J., Wang, S., Zhu, L. I., & Kim, M. (2006). Urban/rural differences in access and barriers to health care for people with multiple sclerosis. *Journal of Health and Human Services Administration, 29*(3) 360–375.

Bugden, D., & Stedman, R. (2019). Rural landowners, energy leasing, and patterns of risk and inequality in the shale gas industry. *Rural Sociology, 84*(3) 459–488. https://doi.org/10.1111/ruso.12236

Bulte, E., & Damania, R. (2008). Resources for sale: Corruption, democracy and the natural resource curse. *The B.E. Journal of Economic Analysis & Policy, 8*(1). https://doi.org/10.2202/1935-1682.1890

Bureau of Economic Analysis (BEA). (2018). Small area data. Retrieved June 3, 2018, from https://www.bea.gov/data

Bureau of Labor Statistics (BLS). (2018). Labor force dat. Retrieved June 3, 2018, from https://www.bls.gov/data/

Caliendo, M., & Kopeinig, S. (2008). Some practical guidance for the implementation of propensity score matching. *Journal of Economic Surveys, 22*(1), 31–72.

Cai, Z., Maguire, K., & Winters, J. V. (2019). Who benefits from local oil and gas employment? Labor market composition in the oil and gas industry in Texas and the rest of the United States. *Energy Economics*, 104515.

Carr, P. J., & Kefalas, M. J. (2009). Hollowing out the middle: The rural brain drain and what it means for America. Boston, MA: Beacon Press.

Casey, J. A., Wilcox, H. C., Hirsch, A. G., Pollak, J., & Schwartz, B. S. (2018). Associations of unconventional natural gas development with depression symptoms and disordered sleep in Pennsylvania. *Scientific Reports, 8*(1). doi:10.1038/s41598-018-29747-2

Chan, L., Hart, L. G., & Goodman, D. C. (2006). Geographic access to health care for rural Medicare beneficiaries. *The Journal of Rural Health, 22*(2), 140–146. https://doi.org/10.1111/j.1748-0361.2006.00022.x

Clifford, W. B., Miller, M. K., & Stokes, C. S. (1986). Rural-urban differences in mortality in the United States, 1970 to 1980. *Rural Sociology, 50*, 210–224.

Clifford, W. B., & Brannon, Y. S. (1985). Rural-urban differentials in mortality. *Rural Sociology, 50*(2), 210–224.

Corey, J., & McMahon, F. (December 17, 2009). Development in US states, economic freedom, and the 'resource curse.' Fraser Institute Studies in Mining Policy, Forthcoming. doi:10.2139/ssrn.1816802

Cortese, C. F., & Jones, B. (1977). The sociological analysis of boom towns. *Western Sociological Review, 8*(1), 76–90.

Cosby, A. G., McDoom-Echebiri, M. M., James, W., Khandekar, H., Brown, W., & Hanna, H. L. (2019). Growth and persistence of place-based mortality in the United States: The rural mortality penalty. *American Journal of Public Health, 109*(1), 155–162. https://doi.org/10.2105/AJPH.2018.304787

Cosby, A. G., Neaves, T. T., Cossman, R. E., Cossman, J. S., James, W. L., Feierabend, N. … Farrigan, T. (2008). Preliminary evidence for an emerging nonmetropolitan mortality penalty in the United States. *American Journal of Public Health, 98*(8), 1470–1472. https://dx.doi.org/10.2105%2FAJPH.2007.123778

Cossman, J. S., James, W. L., Cosby, A. G., & Cossman, R. E. (2010). Underlying causes of the emerging nonmetropolitan mortality penalty. *American Journal of Public Health, 100*(8), 1417–1419. https://dx.doi.org/10.2105%2FAJPH.2009.174185

Deziel, N. C., Humeau, Z., Elliott, E. G., Warren, J. L., & Niccolai, L. M. (March 23, 2018). Shale gas activity and increased rates of sexually transmitted infections in Ohio, 2000–2016. *PloS ONE, 13*(3). https://doi.org/10.1371/journal.pone.0194203

Ezzati, M., Friedman, A. B., Kulkarni, S. C., & Murray, C. J. L. (May 13, 2008). The reversal of fortunes: Trends in county mortality and cross-county mortality disparities in the United States. *PLoS Med, 5*(4). https://doi.org/10.1371/journal.pmed.0050119

Fernando, F. N., & Cooley, D. R. (2016). An oil boom's effect on quality of life (QoL): Lessons from western North Dakota. *Applied Research in Quality of Life, 11*(4), 1083–1115. doi:10.1007/s11482-015-9422-y

Filteau, M. R. (2015). A localized masculine crisis: Local men's subordination within the Marcellus Shale Region's masculine structure. *Rural Sociology, 80*(4), 431–455. https://doi.org/10.1111/ruso.12072

Filteau, M. R. (2016). "If you talk badly about drilling, you're a pariah": Challenging a capitalist patriarchy in Pennsylvania's Marcellus Shale Region. *Rural Sociology, 81*(4), 519–544. https://doi.org/10.1111/ruso.12107

Fisher, M. P., Mayer, A., Vollet, K., Hill, E. L., & Haynes, E. N. (2018). Psychosocial implications of unconventional natural gas development: Quality of life in Ohio's Guernsey and Noble Counties. *Journal of Environmental Psychology, 55*, 90–98. https://doi.org/10.1016/j.jenvp.2017.12.008

Frank, K. A., Maroulis, S. J., Duong, M. Q., & Kelcey, B. M. (2013). What would it take to change an inference? Using Rubin's causal model to interpret the robustness of causal inferences. *Educational Evaluation and Policy Analysis, 35*(4), 437–460. https://doi.org/10.3102%2F0162373713493129

Frankel, J. A. (March 2010). *The natural resource curse: A survey*. Working paper #15836). Cambridge, MA: National Bureau of Economic Research. doi:10.3386/w15836

Freudenburg, W. R., Bacigalupi, L. M., & Landoll–Young, C. (1982). Mental health consequences of rapid community growth: A report from the longitudinal study of boomtown mental health impacts. *Journal of Health and Human Resources Administration, 4*(3), 334–352.

Haines, M. R. (2001). The urban mortality transition in the United States, 1800–1940. *Annales de démographie historique, 101* (1), 33–64. doi:10.3917/adh.101.0033

Hainmueller, J. (2012). Entropy balancing for causal effects: A multivariate reweighting method to produce balanced samples in observational studies. *Political Analysis, 20*(1), 25–46. https://dx.doi.org/10.2139/ssrn.1904869

Hainmueller, J., & Xu, Y. (September, 2013). Ebalance: A Stata package for entropy balancing. *Journal of Statistical Software, 54*(7). doi:10.2139/ssrn.1943090

Helm, J. M., Zhong, A. C., Villegas, E., & Joseph, S. (2017). Is there an increased incidence of retroperitoneal malignancies due to fracking? *Journal of Public Health Policy and Planning, 1*(1) 13–16.

Higgs, R., & Booth, D. (1979). Mortality differentials within large American cities in 1890. *Human Ecology, 7*(4), 353–370. doi:10.1007/BF00888102

Hill, E. L. (2018). Shale gas development and infant health: Evidence from Pennsylvania. *Journal of Health Economics, 61*, 134–150. https://doi.org/10.1016/j.jhealeco.2018.07.004

Hirsch, J. K., Smalley, K. B., Selby-Nelson, E. M., Hamel-Lambert, J. M., Rosmann, M. R., Barnes, T. A. … LaFromboise, T. D. (2018). Psychosocial impact of fracking: A review of the literature on the mental health consequences of hydraulic fracturing. *International Journal of Mental Health and Addiction, 16*(1), 1–15. https://doi.org/10.1007/s11469-017-9792-5

Jacquet, J., & Kay, D. L. (2014). The unconventional boomtown: Updating the impact model to fit new spatial and temporal scales. *Journal of Rural and Community Development, 9*(1), 1–23.

Jacquet, J. B. (2012). Landowner attitudes toward natural gas and wind farm development in northern Pennsylvania. *Energy Policy, 50*, 677–688.

Jacquet, J. B., & Stedman, R. C. (2013). Perceived impacts from wind farm and natural gas development in northern Pennsylvania. *Rural Sociology, 78*(4), 450–472. https://doi.org/10.1111/ruso.12022

James, A., & Aadland, D. (2011). The curse of natural resources: An empirical investigation of U.S. counties. *Resource and Energy Economics, 33*(2), 440–453. doi:10.1016/j.reseneeco.2010.05.006

James, A., & Smith, B. (2017). There will be blood: Crime rates in shale-rich US counties. *Journal of Environmental Economics and Management, 84*, 125–152.

James, W. L. (2014). All rural places are not created equal: Revisiting the rural mortality penalty in the United States. *American Journal of Public Health, 104*(11), 2122–2129. https://dx.doi.org/10.2105%2FAJPH.2014.301989

Kaufman, B. G., Thomas, S. R., Randolph, R. K., Perry, J. R., Thompson, K. W., Holmes, G. M., & Pink, G. H. (2016). The rising rate of rural hospital closures. *The Journal of Rural Health, 32*(1), 35–43. doi:10.1111/jrh.12128

Kohrs, E. V. (1974*).* Social consequences of boom growth in Wyoming. Retrieved November 9, 2019, from https://www.sublettewyo.com/Archive/ViewFile/Item/97

Komarek, T., & Cseh, A. (2017). Fracking and public health: Evidence from gonorrhea incidence in the Marcellus Shale region. *Journal of Public Health Policy, 38*(4), 464–481. https://doi.org/10.1057/s41271-017-0089-5

Komarek, T. M. (2016). Labor market dynamics and the unconventional natural gas boom: Evidence from the Marcellus region. *Resource and Energy Economics, 45*, 1–17. https://doi.org/10.1016/j.reseneeco.2016.03.004

Krannich, R. S., & Greider, T. (1984). Personal well-being in rapid growth and stable communities: Multiple indicators and contrasting results. *Rural Sociology, 49*(4), 541.

Ladd, A. E. (2014). Environmental disputes and opportunity–Threat impacts surrounding natural gas fracking in Louisiana. *Social Currents, 1*(3), 293–311. https://doi.org/10.1177%2F2329496514540132

Li, P., Schneider, J. E., & Ward, M. M. (2009). Converting to critical access status: How does it affect rural hospitals' financial performance? *INQUIRY: The Journal of Health Care Organization, Provision, and Financing, 46*(1), 46–57. https://doi.org/10.5034%2Finquiryjrnl_46.01.46

Lichter, D. T., & McLaughlin, D. K. (1995). Changing economic opportunities, family Structure, and poverty in rural areas. *Rural Sociology, 60*(4), 688–706. https://doi.org/10.1111/j.1549-0831.1995.tb00601.x

Litaker, D., Koroukian, S. M., & Love, T. E. (2005). Context and healthcare access: Looking beyond the individual. *Medical care, 43*(6), 531–540.

Malin, S. (2014). There's no real choice but to sign: Neoliberalization and normalization of hydraulic fracturing on Pennsylvania farmland. *Journal of Environmental Studies and Sciences, 4*(1), 17–27. doi:10.1007/s13412-013-0115-2

Maniloff, P., & Mastromonaco, R. (2017). The local employment impacts of fracking: A national study. *Resource and Energy Economics, 49*, 62–85. doi:10.1016/j.reseneeco.2017.04.005

Marcus, J. (2013). The effect of unemployment on the mental health of spouses–Evidence from plant closures in Germany. *Journal of Health Economics, 32*(3), 546–558. doi:10.1016/j.jhealeco.2013.02.004

Mayer, A. (2017). Will democratization save the climate? An entropy-balanced, random slope study. *International Journal of Sociology, 47*(2), 81–98.

Mayer, A. (2018a). The fiscal impacts of energy: Perspectives from local governments in the Mountain West, USA. *Energy policy, 122*, 186–193.

Mayer, A. (2018b). Energy transition and rural hospital closure: Leaving rural America behind? *Environmental Justice, 11*(2), 71–76.

Mayer, A, Malin, S. A., & Olson-Hazboun, S. K. (2018). Unhollowing rural America? Rural human capital flight and the demographic consequences of the oil and gas boom. *Population and Environment, 39*(3), 219–238.

Mayer, A., Olson-Hazboun, S. K., & Malin, S. (2018). Fracking fortunes: Economic well-being and oil and gas development along the urban-rural continuum. *Rural Sociology, 83*(3), 532–567.

Mayer, A., & Hazboun, S. O. (2019). Does fracking drive you to drink? Unconventional oil and gas production and alcohol consumption in US counties. *The Extractive Industries and Society*, *6*(3), 823–830.

McHenry, K. A. (2017). Fracking women: A feminist critical analysis of hydraulic fracturing in Pennsylvania. *International Journal of Feminist Approaches to Bioethics, 10*(2), 79–104. https://doi.org/10.3138/ijfab.10.2.79

McHenry-Sorber, E., Schafft, K. A., Burfoot-Rochford, I., & Hall, D. (2016). The masculinized work of energy development: Unequal opportunities and risks for women in Pennsylvania shale gas boomtown communities. *Journal of Rural Social Sciences, 31*(1) 1–23.

McKenzie, L. M., Allshouse, W. B., Byers, T. E., Bedrick, E. J., Serdar, B., & Adgate, J. L. (2017). Childhood hematologic cancer and residential proximity to oil and gas development. *PloS ONE, 12*(2), https://doi.org/10.1371/journal.pone.0170423

McKenzie, L. M., Guo, R., Witter, R. Z., Savitz, D. A., Newman, L. S., & Adgate, J. L. (2014). Birth outcomes and maternal residential proximity to natural gas development in rural Colorado. *Environmental Health Perspectives, 122*(4), 412–417. https://doi.org/10.1289/ehp.1306722

McKenzie, L. M., Witter, R. Z., Newman, L. S., & Adgate, J. L. (2012). Human health risk assessment of air emissions from development of unconventional natural gas resources. *Science of the Total Environment, 424*, 79–87. https://doi.org/10.1016/j.scitotenv.2012.02.018

Mehlum, H., Moene, K., & Torvik, R. (2006). Institutions and the resource curse. *The Economic Journal, 116*(508), 1–20. https://doi.org/10.1111/j.1468-0297.2006.01045.x

Miller, M. K., Stokes, C. S., & Clifford, W. B. (1987). A comparison of the rural–urban mortality differential for deaths from all causes, cardiovascular disease and cancer. *The Journal of Rural Health, 3*(2), 23–34. https://doi.org/10.1111/j.1748-0361.1987.tb00165.x

Munasib, A., & Rickman, D. S. (2015). Regional economic impacts of the shale gas and tight oil boom: A synthetic control analysis. *Regional Science and Urban Economics, 50*, 1–17. https://doi.org/10.1016/j.regsciurbeco.2014.10.006

Murray, C. J. L., Kulkarni, S. C., Michaud, C., Tomijima, N., Bulzacchelli, M. T., Iandiorio, T. J., & Ezzati, M. (2006). Eight Americas: Investigating mortality disparities across races, counties, and race-counties in the United States. *PLOS Medicine, 3*(9). doi:10.1371/journal.pmed.0030260

Newell, R. G., & Raimi, D. (2018a). US state and local oil and gas revenue sources and uses. *Energy Policy*, *112,* 12–18.

Newell, R. G., & Raimi, D. (2018b). The fiscal impacts of increased US oil and gas development on local governments. *Energy policy*, *117*, 14–24.

O'Connor, C. D. (2015). Insiders and outsiders: Social change, deviant others, and sense of community in a boomtown. *International Journal of Comparative and Applied Criminal Justice, 39*(3), 219–238. https://doi.org/10.1080/01924036.2014.973049

O'Shaughnessy, S., & Krogman, N. T. (2011). Gender as contradiction: From dichotomies to diversity in natural resource extraction. *Journal of Rural Studies, 27*(2), 134–143. https://doi.org/10.1016/j.jrurstud.2011.01.001

Papyrakis, E., & Gerlagh, R. (2004). The resource curse hypothesis and its transmission channels. *Journal of Comparative Economics, 32*(1), 181–193. doi:10.1016/j.jce.2003.11.002

Perry, S. L. (2012). Development, Land use, and collective trauma: The Marcellus Shale gas boom in rural Pennsylvania. *Culture, Agriculture, Food and Environment, 34*(1), 81–92. https://doi.org/10.1111/j.2153-9561.2012.01066.x

Picard, R. (2012). GEONEAR: Stata module to find nearest neighbors using geodetic distances. https://ideas.repec.org/c/boc/bocode/s457146.htmls

Pippert, T., & Zimmer Schneider, R. (2018). "Have you been to Walmart?" Gender and perceptions of safety in North Dakota boomtowns. *The Sociological Quarterly, 59*(2), 234–249. https://doi.org/10.1080/00380253.2017.1413602

Quam-Wickham, N. (1999). Rereading man's conquest of nature: Skill, myths, and the historical construction of masculinity in western extractive industries. *Men and Masculinities, 2*(2), 135–151. https://doi.org/10.1177%2F1097184X99002002002

Ricketts, T. C., III. (1999). *Rural health in the United States*. New York, NY: Oxford University Press.

Rickman, D. S., Wang, H., & Winters, J. V. (2017). Is shale development drilling holes in the human capital pipeline? *Energy Economics, 62*, 283–290. doi:10.1016/j.eneco.2016.12.013

Sachs, J. D., & Warner, A. M. (2001). The curse of natural resources. *European Economic Review, 45*(4), 827–838. doi:10.1016/S0014-2921(01)00125-8

Sala-i-Martin, X., & Subramanian, A. (2013). Addressing the natural resource curse: An illustration from Nigeria. *Journal of African Economies, 22*(4), 570–615. https://doi.org/10.1093/jae/ejs033

Schafft, K. A., Borlu, Y., & Glenna, L. (2013). The relationship between Marcellus Shale gas development in Pennsylvania and local perceptions of risk and opportunity. *Rural Sociology, 78*(2), 143–166. https://doi.org/10.1111/ruso.12004

Singh, G. K., & Siahpush, M. (2002). Increasing rural–urban gradients in US suicide mortality, 1970–1997. *American Journal of Public Health, 92*(7), 1161–1167. https://dx.doi.org/10.2105%2Fajph.92.7.1161

Smith, J. M. (2014). *Mining coal and undermining gender: Rhythms of work and family in the American west*. New Brunswick, NJ: Rutgers University Press.

Smith, J. A., & Todd, P. E. (2001). Reconciling conflicting evidence on the performance of propensity-score matching methods. *American Economic Review, 91*(2), 112–118.

Truex, R. (2014). The returns to office in a "rubber stamp" parliament. *American Political Science Review, 108*(2), 235–251. https://doi.org/10.1017/S0003055414000112

U.S. Census. (2018). Country population data. Retrieved June 3, 2018, from https://www.census.gov/data/tables/time-series/demo/popest/2010s-counties-total.html

Xu, R., Frank, K. A., Maroulis, S. J., & Rosenberg, J. M. (2019). konfound: Command to quantify robustness of causal inferences. *The Stata Journal, 19*(3), 523–550.

Weber, J. G. (2012). The effects of a natural gas boom on employment and income in Colorado, Texas, and Wyoming. *Energy Economics, 34*(5), 1580–1588. http://dx.doi.org/10.1016/j.eneco.2011.11.013

Weinstein, A. L., Partridge, M. D., & Tsvetkova, A. (2018). Follow the money: Aggregate, sectoral and spatial effects of an energy boom on local earnings. *Resources Policy, 55*, 196–209. doi:10.1016/j.resourpol.2017.11.018

Williams, C. L., Kilanski, K., & Muller, C. (2014). Corporate diversity programs and gender inequality in the oil and gas industry. *Work and Occupations, 41*(4), 440–476. https://dx.doi.org/10.1177%2F0730888414539172

Wilkinson, K. P., Thompson, J. G., Reynolds, R. R., Jr., & Ostresh, L. M. (1982). Local social disruption and western energy development: A critical review. *Pacific Sociological Review, 25*(3), 275–296. doi:10.2307/1388767

Zhao, Q., & Percival, D. (2017). Entropy balancing is doubly robust. *Journal of Causal Inference, 5*(1). https://doi.org/10.1515/jci-2016-0010