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# Economic change, the death of the coal industry, and migration intentions in rural Colorado, USA

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## Cover Page Footnote

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ABSTRACT
Significant portions of the rural U.S. are struggling with out-migration and subsequent population loss. The U.S. energy system is also undergoing a very fundamental transition with the marked decline of the coal industry and the growth of natural gas and renewables. Although the collapse of coal holds many benefits in terms of public health and environmental quality, it could exacerbate problems of population loss. In this analysis, we evaluate how the pending collapse of the coal industry in western Colorado could influence migration intentions using survey data. We find that the decline of the coal industry likely has no substantive influence on migration intentions. Our findings suggest that the collapse of the coal industry will likely not lead to significant out-migration from rural places.

KEYWORDS
Coal, migration, rural development

## INTRODUCTION

The rural U.S. has long been the site of significant demographic change due to migration. Throughout most of the twentieth century, non-metro areas typically experienced slower population growth than urban spaces (Lobao and Meyer 2001). Over the last few decades, patterns of population change between rural and urban areas have diverged, with large sections of the rural U.S. *losing* population, rather than simply experiencing slower population growth (Cromartie 2017; McGranahan, Cromartie, and Wojan 2011; Mayer, Malin, and Hazboun 2018; Johnson and Lichter 2019). The causes of this population loss are complex, but many of them are rooted in the economic changes brought by de-skilling and automation of conventional rural livelihoods, globalization, and general lack of economic opportunity (Flora 1992; Bell, Hullinger, and

Brislen 2015). Indeed, the literature is replete with evocative terminology to describe this problem, such as “hollowed out,” “left behind,” and “swept out” (Carr and Kefalas 2009; Wuthnow 2019; Jacquet, Guthrie, and Jackson 2017).

The rural U.S. also faces other unique challenges and opportunities. Among these are the rapid and far-reaching changes in the way that the U.S. is producing energy. The mid-2000s saw a marked uptick in oil and gas production because of the convergence of a favorable regulatory environment and technologies like directional drilling, underground mapping, and hydraulic fracturing (Mayer and Malin 2019; Warner and Shapiro 2013; Saundry 2019). This energy transition has important implications for rural places that have historically provided baseload fuels for the U.S. energy system. One of these consequences is the rapid contraction of the coal industry, with dozens of mines and coal fired power plants closing over the last decade as coal has been replaced by natural gas and, to a much less extent, renewables such as wind (Houser, Bordoff, and Marsters 2017; Haggerty et al. 2018; AWEA 2019). Although the decline of coal holds immense benefits for public health and environmental quality (e.g. Hendryx and Ahern 2008; Martenies et al. 2019), the collapse of this industry does create complications for rural places that have historically relied upon it for tax revenue and jobs (Haggerty et al. 2018).

In this analysis, we link two areas that have not been explicitly connected in the literature: the energy transition—particularly the collapse of the coal sector—and the challenge of rural out-migration. We ask how coal mine closures might impact the migration intentions of rural residents of a region of Colorado, USA, that has historically hosted a large coal industry. The next section describes the relevant literature on rural population change in the U.S.

## RURAL POPULATION CHANGE

Migration, rather than natural increase or decrease, is often the primary driver of population change in the rural U.S (Johnson and Fuguitt 2000; Johnson et al. 2005; Nelson 2001; Winkler et al. 2012). Yet there is also important diversity in the demographic experiences of rural places. Rural counties adjacent to metropolitan areas often experience higher population growth rates than more isolated counties (Johnson 2012). Further, counties rich in natural and cultural amenities have generally seen significant population growth in the last few decades, while many low amenity counties are shedding population (Saint Onge, Hunter, and Boardman 2007; Rickman and Rickman 2011).

Not all demographic groups are equally likely to out-migrate from rural places. Rather, in a phenomenon that has been dubbed “brain drain,” higher educated and working-age adults are more inclined to out-migrate than older residents or those with less formal education (Carr and Kafalas 2009; Petrin, Schafft, and Meece 2014). This selective out-migration engenders challenges for rural places, as retaining educated, working-age populations is essential for generating sorely needed tax revenue and economic growth in struggling rural places.

There are several studies of out-migration in rural places (e.g. Ulrich-Schad, Henly, and Safford 2013; Seyfrit 1986). Although economic considerations (e.g. lack of employment opportunities) are a major push factor causing population loss in rural places, the literature paints a much more complicated picture on why some stay and others choose to leave. People make subjective assessments about their communities in terms of social connections, natural amenities, and other factors, and these can collectively encourage or discourage out-migration (Ulrich-Schad et al. 2013). Ties to friends, family, desire for a rural lifestyle, and cultural connections to places can anchor people who might otherwise out-migrate for economic opportunity (Pretty et al. 2006; Seyfrit and Hamilton 1992). Indeed, a large literature describes “sense of place,” “place attachment,” “community sentiment,” or “communities of place” (Trentelman 2009; Pretty et al. 2006; Hidalgo and Hernandez 2001). The theoretical nuances of this work varies and there are currently no consensus definitions of these concepts employed by all scholars of migration and rural demography. Yet the core notion of all these studies is that places are not simply viewed by their inhabitants as an instrumental source of economic opportunity. Rather, places are imbued with socio-cultural meaning by residents via a variety of processes, ranging from day-to-day interactions to cultural rituals (Scannell and Gifford 2010).

Yet, as we detail below, migration intentions in the context of the current energy transition—which involves the increasing viability of renewables and natural gas and the concomitant collapse of coal—are not well understood. We describe the potential connections between the current energy transition in the U.S. and migration decisions in the next section, with a special focus on the declining coal industry.

## ENERGY TRANSITION AND COAL

Rural places have historically provided for the energy needs of the United States. Energy extraction and production, particularly from fossil fuels, has long been associated with the “paradox of plenty” or “natural resource curse” (Mayer, Olson Hazboun, and Malin 2018; Freudenburg 1992; Frankel 2010; Auty 2007). A large body of literature suggests that centering a local or regional economy on extractive industries often leads to anemic economic development and deeply entrenched poverty (Mayer et al. 2018; James and Aadland 2011; Gilberthorpe and Papyrakis 2015), despite the wealth generated by extractive activities. The coal industry in the U.S, especially in Appalachia, is tightly coupled to the economic and social maladies that have historically troubled this region (Nyden 1979; Perdue and Pavela 2012; Greenberg 2017), where coal enriches a few but exacerbates local inequalities (Duncan 2014). Coal causes several poor health outcomes through mechanisms like air pollution and water contamination (Hendryx 2008; Hendryx and Ahern 2008; Martenies et al. 2019) and is perhaps the largest global contributor to climate change (Jakob et al. 2020). The coal industry is currently undergoing a sharp contraction in the U.S., caused in large part by the abundance of inexpensive natural gas and, to a lesser extent, by environmentally advantageous and increasingly economically viable renewables like solar and wind (Houser et al. 2017; Cha 2020). In most parts of the U.S., natural gas is the most inexpensive fuel source for electricity generation, and in many parts of the U.S., renewables can provide electricity more inexpensively than coal (Energy Institute 2020). Coal, beyond its profoundly deleterious health and environmental impacts, is simply unattractive economically as a fuel source in the current U.S. energy system, a situation that is unlikely to change.

A related body of literature has identified “boomtown” problems that occur during the expansion phase of natural resource development (Bacigalupi and Freudenburg 1983; Freudenburg 1981). Most relevant to this study, this body of work describes how a sudden influx of young men seeking work in the natural resource sector can create complications for communities, ranging from increased crime to strain on infrastructure (England and Albrecht 1984; Ennis, Finlayson, and Speering 2013; Gramling and Brabrant 1986; O’Connor 2015; Pippert and Schneider 2018). After the boom period, a bust inevitably follows, presumably causing population loss as the young, mostly male workers leave the community for other opportunities. Like the literature on the natural resource curse, the boomtown perspective strongly suggests that natural resource development, particularly in the form of extractive industries, will leave communities worse-off in the long run (Freudenburg and Wilson 2002; Jacobsen and Parker 2016).

Although coal has long been associated with natural resource dependence and concomitant economic under-development in many regions, we also cannot conversely assume that suddenly removing coal mining from communities will allow them to flourish economically and socially. Although it has many negative spillovers, the coal industry also provides jobs that are relatively high-paying, especially for isolated, rural places with few economic prospects. Further, in some places coal provides a large portion of local tax revenue, creating a potential local fiscal crisis as the industry continues its contraction (Haggerty et al. 2018; Harrahill and Douglas 2019; Snell 2018; Mayer 2018). Extractive industries tend to crowd out other sectors, limiting the economic diversification potential of some rural areas (Freudenburg 1992). The coal industry will likely leave behind a visual legacy of blighted facilities, damaged landscapes, and environmental contamination that will last for decades, both of which can serve to limit economic development opportunities like tourism (e.g. Colocousis 2012). That is, the collapse of coal—while it will certainly provide many long-term and broadly shared benefits—does present a range of complications for regions that have been historically reliant upon it, even as this collapse brings many welcome changes and broad de-carbonization and public health benefits.

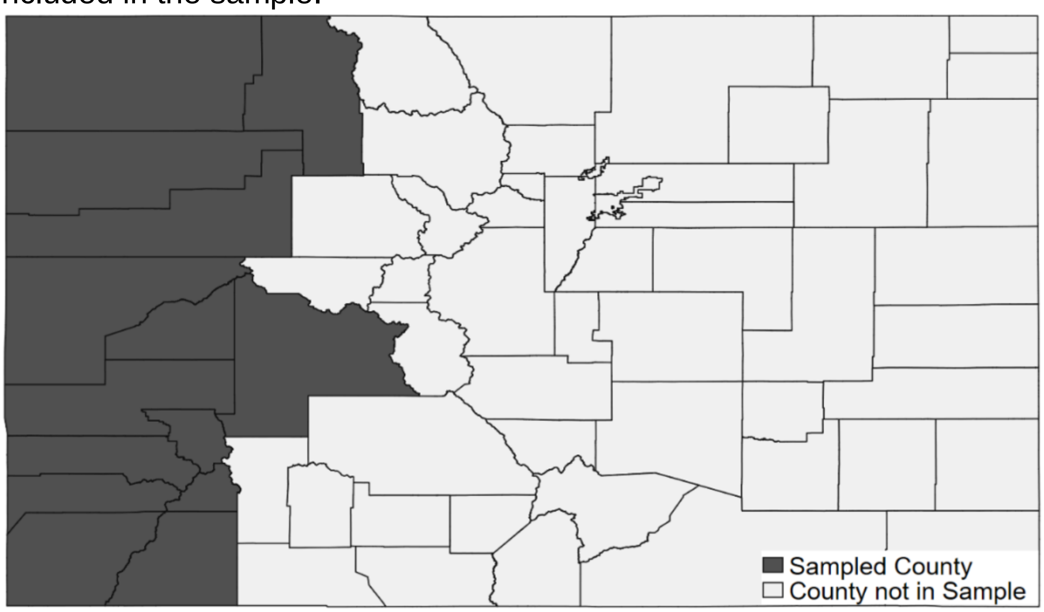
The literature provides some clues as to the effect of coal mine closures on migration intentions. Early, we noted that economic considerations are a primary, but not the only, determinant of rural out-migration. In the immediate aftermath of the closure of a mine, out-migration may be more likely as jobs leave the area and the host community struggles with lost tax revenue that erodes the quality of local infrastructure and services. In the next section, we describe the region where we conducted the present study.

## STUDY REGION

We situate our research in western Colorado. With some notable exceptions most of the touchstone research on coal mining in the U.S. has been conducted in Appalachia, with comparatively fewer studies of the mountain West region (e.g. Smith 2014; Haggerty et al. 2018). Colorado has historically been a large producer of coal, with most mines concentrated in the relatively sparsely populated Western region of the state. This area is home to some 450,000 residents (out of a state population of 5.7 million) and is located a significant distance from the state's population centers along the eastern range of the Rocky Mountains. Colorado provides a useful region to study for scholars working on issues of rural development and energy transitions. Compared to more commonly studied locales (e.g. Appalachia), Colorado has a diverse economy that has grown rapidly in recent decades but has rural regions that struggle with population loss and anemic economic development, while others enjoy booming recreation and renewable energy industries (e.g. Bell Policy Center 2020).

At the time of data collection, the region was home to six active mines that each employed between 100 and 400 people. Figure 1 provides a map of the study region, with sampled counties shaded and the location of the active coal mines. The following counties are included in our sample: Moffat, Routt, Rio Blanco, Garfield, Mesa, Delta, Gunnison, Montrose, Ouray, San Miguel, San Juan, Delores, La Plata, and Montezuma.

Figure 1: Map of Study Region in Western Colorado. Shaded counties are included in the sample.




The current analysis is part of a larger project evaluating energy transitions in the Mountain West region—this work is funded by the Rural Sociological Society and various internal sources. Although most of the counties are rural, with relatively small populations, there is a significant degree of economic diversity in the study region. Some counties (e.g. Gunnison County) are largely situated within the Rocky Mountains and enjoy natural and cultural amenities that drive amenity migration and a thriving tourism economy. On the other hand, counties such as Rio Blanco and Moffat in the northern reaches of the state exhibit many of the features of natural resource dependent regions—for instance, some 60 percent of property taxes in Moffat County are paid by the coal industry, and the county is steadily losing population (Brasch 2020).

After receiving IRB approval, we conducted 14 qualitative interviews with informants involved in economic development and diversification efforts in the study region. These informants were recruited via chain referral sampling (Heckathorn and Cameron 2017). The qualitative interviews were used to inform survey development—we proceeded through our interview notes in an inductive manner to develop the survey. This step was essential because there is relatively little survey-based research on migration intentions in the context of the changing energy sector. We also conducted cognitive pre-testing with a convenience sample of Colorado residents.

## DATA

We contracted with Qualtrics, a survey research firm, to collect online panel data in October 2019. Online panels are growing in popularity in the social sciences, and leading social science journals routinely publish data from these sources (e.g. Ternes 2018; Quadlin 2018). Recent meta-analyses find that online panels tend to produce results similar to more conventional modes of survey data collection (Walter et al. 2019; Kees et al. 2017), and this type of data is especially useful for early investigations of relatively new topics and difficult to reach populations—such as the current study. In 2019—the year before our data was collected—the counties included in our sample had relatively high levels of internet penetration, ranging from 64 percent to 92 percent (American Community Survey 2021). Qualtrics is an online panel aggregator wherein respondents are recruited from many different dashboard-style websites. We screened respondents for age (over 18) and residence in the study region at the beginning of the survey. The average completion time was 7.5 minutes. Four-hundred eighty-seven respondents entered the survey, with 29 removed for not living in the study region, 14 disqualified due to age, and 6 removed for completing the survey very quickly. After listwise deletion due to missing data, the final sample size for the models presented below is 431.

We took additional steps to ensure data quality. We also examined our responses for satisficing behaviors (i.e. providing the same answer repeatedly throughout the survey to get through it as quickly as possible) but, again, found no indication of this problem. Finally, the survey included a short attention check which all respondents passed. As typically occurs in survey research, our data is not representative of state demographics for age, education, and sex, so we used the entropy balancing technique to create survey weights on these variables (Hainmueller 2012; Hainmueller and Xu 2013; Watson and Elliot 2016).[1] In the next section, we describe the variables used in our analysis.

*Outcome: Migration Intentions*

We adapt an indicator of migration intentions from Ulrich-Schad et al. (2013) that assessed migration intentions within the next five years. Migration intentions have been found to be a valid indicator of future migration behavior (Von Reichert 2006; Lansing et al. 1967; Van Dalen and Henkens 2008). Some 61 percent of respondents indicated that they did not intend on leaving the area within the next five years, while the reminder indicated that they expected to leave the area (Figure 2). This variable is scored where 0=respondent does not intend to migrate, 1= respondent intends to migrate.

*Predictors*

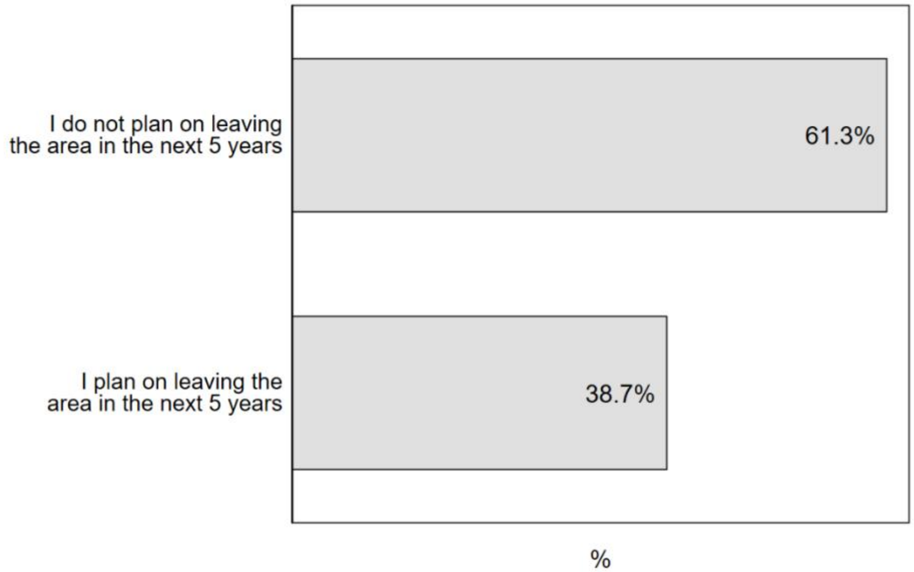
*Effect of coal on migration intentions*

Our first predictor variable is a measure that focuses on the role of the coal industry in influencing migration intentions (e.g. Ulrich-Schad et al. 2013). Respondents were asked “How does the coal industry affect your decision to stay or leave this area?“ and could answer “If the mines and power plants close, I am less likely to leave the area,” “If the mines and power plants close, I am more likely to leave this area,” or “The coal industry has no effect on my decision to stay or leave.” Most (roughly 85 percent) indicated that the coal industry had no effect on their migration intentions, with roughly equal numbers indicating that the coal industry would make them more likely to stay or more likely to out-migrate (see Figure 3).

*Reasons for staying or leaving*

We adapt a series of questions from Ulrich-Schad et al. (2013) to understand the role of community sentiment in migration intentions. These variables represent subjective assessments of the role of various community factors in influencing migration decisions wherein respondents

Figure 2: “Looking ahead, do you expect to continue living in this area for the next 5 years, or move somewhere else?” (N=431)




Note: Question adapted from Ulrich-Schad et al. (2013)

Figure 3: Distribution of “How does the coal industry affect your decision to stay or leave this area?” (N=431)

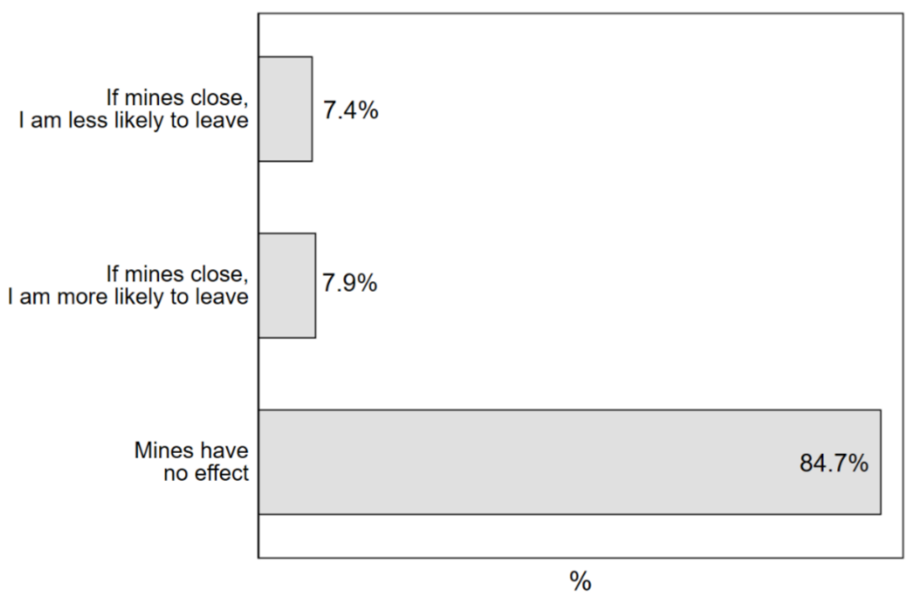
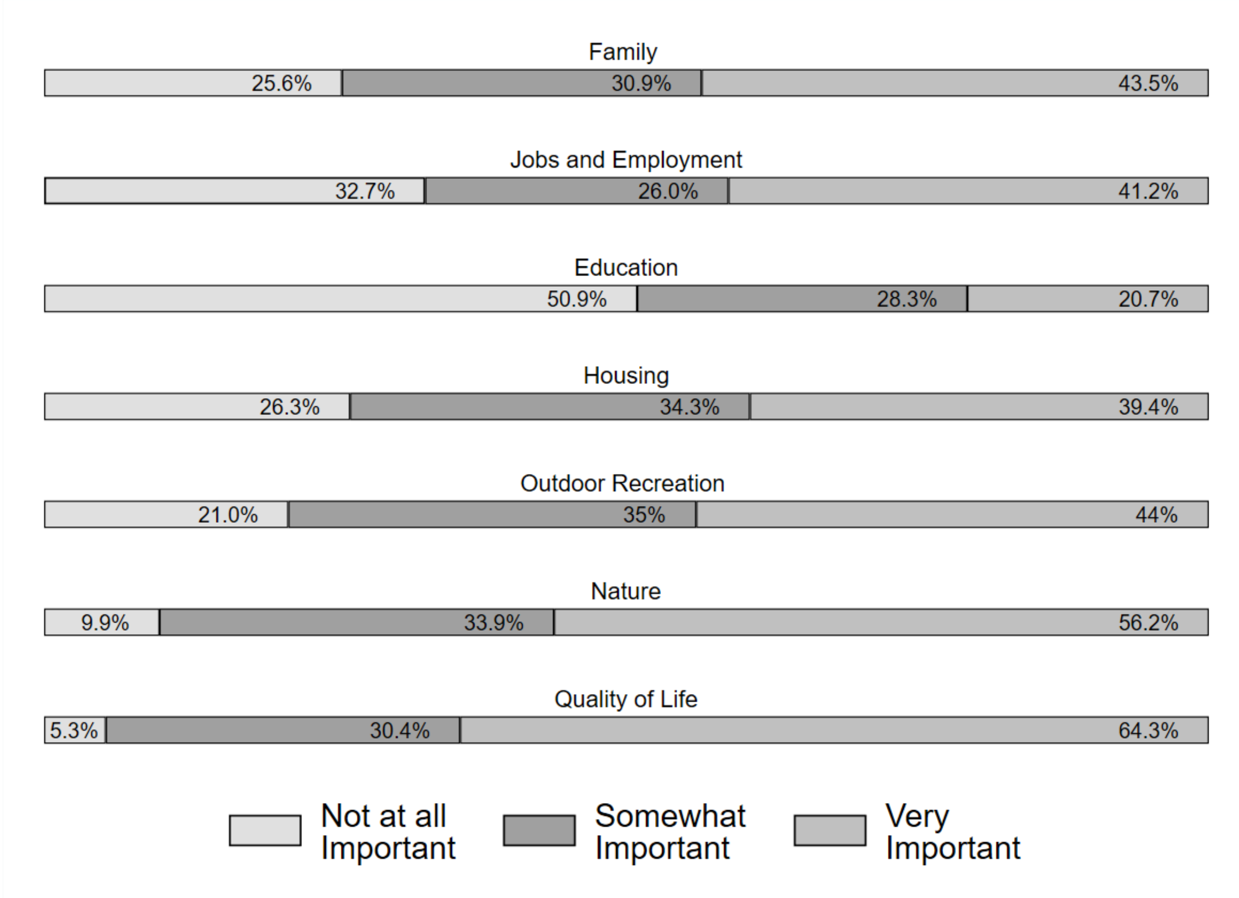


Figure 4: Distribution of “Do the following things seem not important, somewhat important, or very important to you, when you think about whether you will stay here or move away in the future?” (N=431)




Note: Questions derived from Ulrich-Schad et al. (2013)

could rank items like natural amenities or connections to family on a scale of importance (Figure 4).

We modelled the dimensionality of these items by first estimating a polychoric correlation matrix—a type of correlation recommended for ordinal variables—using the iterated principal factors method for extraction and a varimax rotation (Holgado-Tello et al. 2008). Table 1 displays factor loadings and eigenvalues for this procedure, which strongly suggests a two-factor solution. The first and second factor have eigenvalues of 3.2 and 1.4, respectively, and together accounted for nearly 100 percent of the interitem variation. Variables that capture material and economic aspects of place—job opportunities, education, and housing—load strongly on the second factor but minimally on the first. Like Ulrich-Schad et al. (2013), outdoor recreation, nature, and quality of life load strongly on

Table 1: Results of Factor Analysis for Community Sentiment Items (N=431)

| | Eigenvalues | Variance |
|---|---|---|
| Natural Sentiment | 2.302 | 0.680 |
| Practical Sentiment | 1.402 | 0.410 |
| Factor Loadings | | |
| | Factor 1 | Factor 2 |
| Family | - | - |
| Jobs and Employment | - | 0.761 |
| Education | - | 0.772 |
| Housing | - | 0.683 |
| Outdoor Recreation | 0.752 | - |
| Nature | 0.872 | - |
| Quality of life | 0.759 | - |

Note: KMO=0.66. Factors extracted from a polychoric correlation matrix with a varimax rotation.

their own factor, while familial ties did not load on either the first or second factor. Following Ulrich-Schad et al. (2013), we refer to these dimensions as the “practical” and “natural” factors. We calculated factor scores with a mean of zero to use as predictors in our regression equations.

*Control Variables*

Studies of migration intentions routinely control for socio-demographic factors that may also influence migration decisions to avoid potential omitted variable bias. Time spent in a community may root people in place. Accordingly, we include a five-category predictor for years in the community (0=less than 1 year, 1=1 year to 5 years, 2=6-10 years, 3=11-20 years, 4= 20 years or more). We also use controls for age in continuous years, a four-category variable for education (0=high school or less, 1=some college, 2= college, 3= advanced degree), a five-category variable for income (0=under $25,000, 1=$25,001 to $49,999, 2=$50,000-$99,999, 3=$100,000-$149,999, 4=$150,000 or more), and a binary indicator for female gender.[2] Descriptive statistics and descriptions of these variables can be found in Table 2.

*Modelling Strategy*

Given the binary nature of our dependent variable, we use binary logistic regression with the entropy balancing weights to correct for the unrepresentativeness of the sample data. We enter our predictors in three

Table 2: Descriptive Statistics (N=431)

| Variable | Mean | SD | Min | Max |
|---|---|---|---|---|
| Education | | | | |
| High School or Less | 0.279 | 0.449 | 0 | 1 |
| Some College | 0.3 | 0.459 | 0 | 1 |
| College Graduate | 0.349 | 0.477 | 0 | 1 |
| Advanced Degree | 0.073 | 0.26 | 0 | 1 |
| Age | 42.25 | 17.317 | 18 | 85 |
| Income | | | | |
| Less than $25,000 | 0.328 | 0.47 | 0 | 1 |
| $25,000-$49,999 | 0.335 | 0.473 | 0 | 1 |
| $50,000-$99,999 | 0.222 | 0.416 | 0 | 1 |
| $100,000-$149,999 | 0.075 | 0.264 | 0 | 1 |
| $150,000 or more | 0.04 | 0.196 | 0 | 1 |
| Time in community | | | | |
| Less than 1 year | 0.103 | 0.304 | 0 | 1 |
| more than 1 year, less than 5 | 0.204 | 0.403 | 0 | 1 |
| more than 5 years, less than 10 | 0.162 | 0.369 | 0 | 1 |
| more than 10 years, less than 20 | 0.423 | 0.495 | 0 | 1 |
| 20 years or more | 0.108 | 0.31 | 0 | 1 |
| Female | 0.698 | 0.46 | 0 | 1 |

groups. The first model is a “controls” only model that uses only the control variables as predictors (i.e. time in the community, age, income, education, and female sex). The next model adds the predictor for the effect of the loss of mines, and the third model adds the factor scores for community sentiment. Finally, we estimate a fourth “reduced” model that eschews statistically and substantively insignificant predictors from the first three models—the motivation for this step is to remove irrelevant variables that might cause overfitting and hence mask the effect of other predictors. Throughout, we rely upon AIC and BIC statistics to determine improvements in model fit. After estimating the models, we turn to average marginal effects to understand the relative influence of our key predictors more intuitively.

*Regression Results*

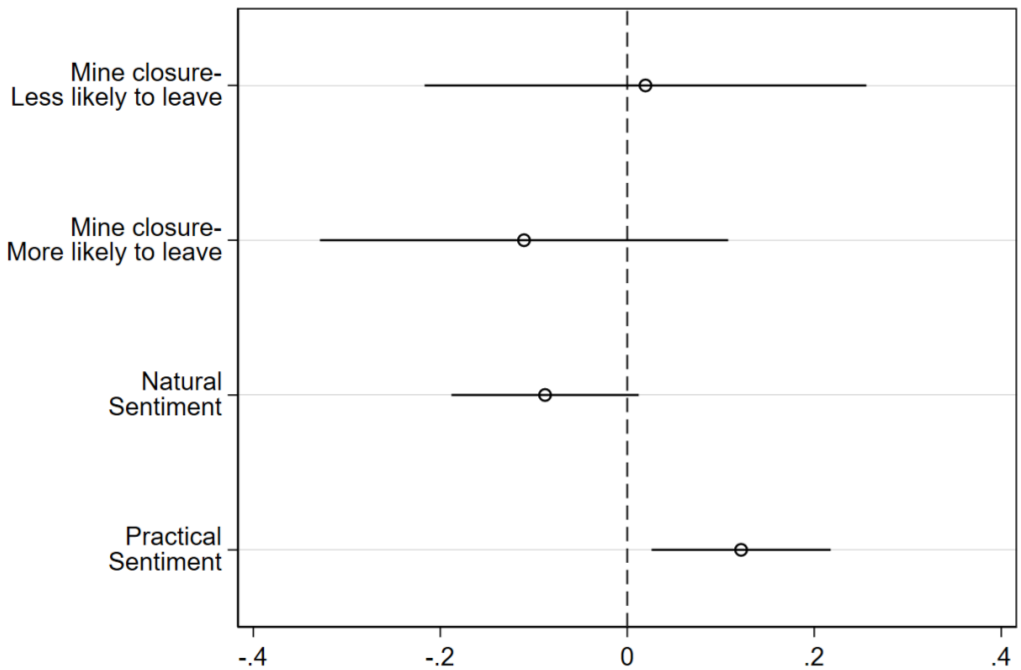
Table 3 displays odds-ratios, standard errors, and flag coefficients for statistical significance. The first model includes only the socio-demographic controls and time spent in the community, with only age (OR=0.972, p=0.001) and income greater than $150,000 (OR=3.382, p=0.033) emerging as statistically significant predictors. Both variables retain their effects in Model 2, where we also add our indicator of how coal mine closure will impact migration decisions. Neither the categories of “coal mine less likely” (OR=0.885, p=0.809) or “coal mine more likely” (OR=0.655, p=0.447) are statistically different from the “no effect” category. Model 3 retains the controls and the coal mine closure variable, and adds in the factor scores for community sentiment. Older respondents are again less likely to report an intention to out-migrate (OR=0.983, p=0.083). The importance of practical sentiment is statistically significant and positive (OR=1.904, p=0.005). That is, as practical factors like education and employment become more important, respondents are more likely to state that they will out-migrate. Importantly, the AIC and BIC statistics have changed as the models have included more variables. The AIC has declined, implying an improved model fit. Yet the BIC, which penalizes for the number of variables in the models, has increased, implying that the models may be over-fit with the inclusion of multiple control variables. Our final model eschews predictors that did not emerge as statistically significant, are not theoretically central to our analysis, and have damaged the BIC. In this final model (Model 4), coal mine closures again appear to have no statistically significant effect and our factor score for practical community sentiment again remains significant (OR=1.720, p=0.016). Further, this simplified model produces the lowest AIC and BIC statistics, implying that this model provides the best fit.

Logistic regression models have well-documented challenges of interpretation (Mood 2010; Williams 2006). To render our modelling results more intuitive, we calculated average marginal effects (AMEs) derived from Model 4 in Table 3. We present these graphically in Figure 5. The AMEs largely corroborate the effects reported in Table 3. Respondents who stated that coal mine closure would make them less likely to leave their area only had a slightly higher likelihood of stating that they intended on migrating within five years—a change in probability of only 0.019. Those who stated that the closure of the mines and power plants would make them more likely to out-migrate had lower migration intentions. That is, the respondents who indicated that they may out-migrate if the coal

Table 3: Logistic Regression Results for Migration Intentions (N=431)

| | Model 1 | | | Model 2 | | | Model 3 | | | Model 4 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | OR | SE | *p* | OR | SE | *p* | OR | SE | *p* | OR | SE | *p* |
| Education (*ref. High School or less*) | | | | | | | | | | | | |
| Some College | 1.46 | 0.50 | 0.27 | 1.42 | 0.50 | 0.31 | 1.45 | 0.51 | 0.29 | | | |
| College Grad | 1.55 | 0.55 | 0.22 | 1.55 | 0.54 | 0.22 | 1.55 | 0.55 | 0.22 | | | |
| Advanced Degree | 2.02 | 1.18 | 0.23 | 1.96 | 1.15 | 0.25 | 1.70 | 1.01 | 0.37 | | | |
| Age | 0.97 | 0.01 | 0.00 | 0.97 | 0.01 | 0.00 | 0.98 | 0.01 | 0.08 | 0.98 | 0.01 | 0.03 |
| Income (*ref. less than $25,000)* | | | | | | | | | | | | |
| $25,000-$49,999 | 0.86 | 0.29 | 0.66 | 0.88 | 0.29 | 0.69 | 0.90 | 0.31 | 0.75 | | | |
| $50,000-$99,999 | 0.54 | 0.21 | 0.10 | 0.53 | 0.20 | 0.09 | 0.50 | 0.19 | 0.07 | | | |
| $100,000-$149,999 | 0.87 | 0.43 | 0.78 | 0.91 | 0.45 | 0.84 | 0.95 | 0.49 | 0.93 | | | |
| $150,000 or more | 3.38 | 1.93 | 0.03 | 3.40 | 2.00 | 0.04 | 4.12 | 2.54 | 0.02 | | | |
| Time in community (*ref less than 1 year)* | | | | | | | | | | | | |
| <1 year | 1.38 | 0.63 | 0.48 | 1.40 | 0.64 | 0.46 | 1.57 | 0.72 | 0.33 | | | |
| >1 year, <5 | 0.80 | 0.40 | 0.65 | 0.82 | 0.41 | 0.69 | 0.87 | 0.44 | 0.78 | | | |
| >5 years, <10 | 0.74 | 0.32 | 0.48 | 0.75 | 0.32 | 0.50 | 0.83 | 0.37 | 0.68 | | | |
| >10 years, <20 | 0.63 | 0.35 | 0.40 | 0.65 | 0.36 | 0.44 | 0.79 | 0.46 | 0.68 | | | |
| ≥20 years | 0.75 | 0.20 | 0.28 | 0.75 | 0.20 | 0.28 | 0.73 | 0.20 | 0.26 | | | |
| Coal mine closure (ref. *no effect*) | | | | | | | | | | | | |
| Coal mine less likely | | | | 0.89 | 0.45 | 0.81 | 0.86 | 0.45 | 0.78 | 1.09 | 0.58 | 0.87 |
| Coal mine more likely | | | | 0.65 | 0.36 | 0.45 | 0.62 | 0.35 | 0.39 | 0.60 | 0.33 | 0.35 |
| Natural | | | | | | | 0.76 | 0.18 | 0.25 | 0.68 | 0.16 | 0.09 |
| Practical | | | | | | | 1.90 | 0.44 | 0.01 | 1.72 | 0.39 | 0.02 |
| AIC | | 489.40 | | | 492.38 | | | 485.66 | | | 480.01 | |
| BIC | | 544.03 | | | 554.82 | | | 555.91 | | | 503.43 | |

Figure 5: Average Marginal Effects and 95% Confidence Intervals for the Effect of Coal Mine Closure and Community Sentiment on Migration Intentions (N=431)




mines closed have less propensity to migrate overall. Still, the estimate of the AME is relatively low (-0.11) and the confidence intervals cross over zero, implying that the status of the coal mines may have no substantive effect on migration intentions. Yet, as we noted earlier, practical community sentiment is a potentially powerful predictor, with an AME of 0.12. Given that this variable ranges from just below 0 to 2, the full effect could be as strong as 0.24—that is, practical community sentiment could change the possibility of reporting the intention to out-migrate by as much as 24 percent.

## DISCUSSION AND CONCLUSION

Non-amenity counties in the rural United States are steadily shedding population, causing significant challenges in terms of economic development, infrastructure, and tax revenue for these places. Concomitant to these demographic changes are major shifts in the energy system which undoubtedly have broad and consequential effects on the rural U.S. The nation’s coal industry is continuing its rapid contraction, potentially creating new economic challenges for rural places. In this paper, we evaluated the link between coal mine closure and migration intentions using survey data from western Colorado. We argued that coal mine closure could exacerbate population loss because of lost employment and declining tax revenue. Our results strongly imply that coal mine closure will have little to no effect on the migration intentions of rural populations. A relatively small number of respondents indicated that coal mines influenced their migration decisions, and, in our regression models, this variable never reached statistical significance and had substantively small effects.

Here we suggest some potential explanations for this seemingly surprising finding. Perhaps the most obvious explanation is that employment in the coal industry has been declining in western Colorado for years, to the point that the mines employee relatively few people in the entire region. Indeed, their economic importance comes primarily in the form of property taxes, not direct employment. Respondents may not believe that the closure of the mines will have other deleterious effects on the community beyond the direct loss of some jobs. Further, the bulk of the research on the coal industry in the U.S. has been conducted in Appalachia, a region where the coal industry appears to have a unique cultural resonance that does not align with its dwindling economic significance (e.g. Bell and York 2010; Lewin 2017). Another possibility is that residents of western Colorado have not been subject to the intense, decades-long, industry-driven "ideology construction" efforts detailed by Bell and York (2010). That is, perhaps there have been fewer industry-driven efforts to forge a collective identity around coal in the region. In the absence of this collective identity, residents may not see the coal industry as uniquely important or special and hence it may not influence their migration decisions. Still, it is important to note that the closure of coal mines and power plants may have some secondary consequences—such as lost local funding for schools and infrastructure—that may indirectly encourage out-migration. That is, if school quality declines or local taxes are raised markedly to make up for lost revenue, some may choose to out-migrate. These factors could be especially important in our study region, as practical community sentiment was a salient predictor in our models. Given that our data is cross-sectional, we cannot observe respondents over time to evaluate how these factors may contribute to out-migration.

Exploring these pathways and comparing multiple regions with different cultural understandings of the coal industry is an important task for future research as the rural U.S. struggles with the problem of population loss. The major shifts occurring the U.S. energy system will likely have far-reaching consequences for the rural U.S., which has historically provided for the nation's energy needs and powered industrialization. This article is far from the final word on the demographic implications of the energy transition, and we encourage future work on demographic composition and migration intentions in the context of the changing energy system. We also encourage scholars to develop more nuanced understandings of natural resource dependence and implement studies that can evaluate how communities can effectively transition to new livelihoods once dependence ends due to the bust of key resource. Work in this area will grow in importance as the U.S. energy system continues its seemingly inevitable change.

## NOTES

[1] Entropy balancing using an algorithm to create weights that balance groups on sample moments (i.e., means, standard deviations, etc). In our application, the weights are used to reflect population means of age, education, and sex. We obtained this data from the American Community Survey (American Community Survey 2020).

[2] We also collected data for race and Hispanic ethnicity. Eighty-five percent of the sample identified as white, which is largely consistent with the majority white population of western Colorado. Because of the lack of variation in this variable, we do not include it as a predictor in our regression equations. Employment tied to the coal industry would likely affect migration intentions if the mines were to close. However, only 2 percent of the sample reported that someone in their household worked directly in the coal mines.

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