Rural forest-based communities, economic shocks, and economic trajectories

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1. INTRODUCTION

Many rural communities in forested regions of the US are in transition due to a combination of macroeconomic forces, technological innovations, and other social changes. Opportunities for employment in traditional natural resource industries (forestry, agriculture and mining) are declining, and many questions remain about the future trajectories of these changing communities (Irwin et al., 2010; Morzillo et al., 2015). The decline of traditional, forest resource-based industries introduces both challenges and opportunities for rural communities. Caught between competing visions of production and amenity-based resource development in the future, many rural forested communities are struggling to replace lost jobs, adequately manage forestlands, and promote realistic and sustainable economic development that preserves both the forest landscape and opportunities to maintain or enhance the local quality of life (Haynes, 2003; Morzillo et al., 2015; van Berkel et al., 2017). While some communities have transitioned away from extractive resource use to amenity-based development, numerous questions remain about the extent, consequences, and dynamics of such economic transitions (Bowe & Marcouiller, 2007; Deller et al., 2001; Gosnell & Abrams, 2011; Marcouiller & Clendenning, 2005; Marcouiller, Kim, & Deller, 2004).

Whether communities are able to restructure successfully their economic base to emphasize natural amenities or new forms of production, and whether such changes will provide high-quality jobs for local residents and lessen inequality, depends on how larger economic, social and environmental changes interact with local characteristics, and the pathways of change that result (Colocousis, 2013; McGranahan, 1999). Distinctions in the vulnerability of these communities to diverse shocks and their ability to adapt to such disruptions creates the potential for interesting variation in the dynamics and outcomes of community transitions. Relevant shocks include changes in demand leading to mill closures, abrupt policy shifts affecting the supply or production of a resource (e.g., the Pacific Northwest Forest Plan, Endangered

Species Act), and interregional migration, often due to amenity tourism, bringing new landowners with new perspectives and management objectives (Bell, 2007; Gosnell & Abrams, 2011; Walker & Fortmann, 2003). Large-scale shocks associated with changes in technology, global trade, policies, and markets are also impacting these communities through broad transformations in global, regional, and local economic activities (Autor, Dorn, & Hanson, 2010; Fort, Pierce, & Schott, 2018; Irwin, Isserman, Kilkenny, & Partridge 2010). Because of both opportunities and threats posed by these numerous and, in some instances, dramatic changes, the stories of these community transitions may not be simple, and may, in fact, involve considerable surprise. Accordingly, a long-term, agile research program focused on understanding how rural forested communities respond to diverse stressors related to economic transitions, and how community characteristics influence patterns of change following disruptions and shocks (Bliss, J.C., Walkingstick, T.L., & C. Bailey, 1998; Crandall & Weber, 2004; Cumming et al., 2005; Deller & Watson, 2016; Leake, Adamowicz, & Boxall, 2006; McSweeney & Coomes, 2011; Stedman, Parkins, & Beckley, 2004; Turner et al., 2003) has great potential to advance scientific knowledge and support economic and community development. In the short term, improved documentation of how these communities are changing provides a logical starting point for research programs focused on the trajectories of rural forested communities.

In this paper we document changing economic and social characteristics of 13,000+ rural forested communities located in the continental US. We use an interdisciplinary, exploratory research approach, integrating insights from applied economics, geography, sociology, and human dimensions of natural resources, to address two intermediate research objectives: (1) assess patterns in changes in employment of community residents and (2) characterize associations between community outcomes and these patterns in changing employment. Our work informs outstanding questions about shifting employment in rural communities and the interactions between such shifts and socioeconomic characteristics of rural communities and

brings attention to forest located rural communities, an under-studied group relative to rural agricultural and coastal communities. Our preliminary findings suggest six distinct groupings based on changing employment and hint at heterogeneous community responses and outcomes associated with these groupings.

2. METHODS

We conducted exploratory empirical analyses to (1) assess patterns in employment changes of community residents and (2) characterize associations between community outcomes and these patterns in changing employment. We used cluster analysis to group communities based on the multivariate similarity of recent changes in the mix of employment by category. We also examined economic and social characteristics of these distinct groupings of communities to explore potential linkages between these groupings and community outcomes and pathways.

Study area

We focused on 14,830 communities positioned within forested regions of the continental US (Figure 1). We selected this set of rural, forest-located communities based on two criteria. First, we identified communities proximate to resources capable of supporting forest-based industries. To do this, as our baseline, we focused on communities with more than 30% forest cover within a 100-mile radius (2011 USGS NLCD). Second, we isolated communities with year-round populations ranging from 500 to 15,000 (US Census Bureau 2010). Communities (i.e., county-subdivisions) meeting both criteria defined our study area (Figure 1). We assert this group represents rural forest-located communities referred to in previous research as “in the middle” (Colgan et al., 2014; Morzillo et al., 2015); in short, these rural communities are positioned in the middle - outside of major wilderness and urban areas. We tested the sensitivity of our selection to distinct forest cover and population threshold criteria, and used feedback from key stakeholders and expert knowledge of several US forest regions to support the final selections

noted above. Our interest in this group of rural communities stems from our ongoing research program focused on the resiliency of rural, forest located communities in the face of diverse shocks (Morzillo et al. 2015; Van Berkel et al. 2018). This group of communities provides an excellent study area for our analysis because of their diverse forms of forest dependence, socioeconomic variation, and broad spatial extent. In 2010, these 14,830 communities (Figure 1) represented 33% of the continental US land area, about 18% of the US population, and about 46% of the continental US forest cover.

Data

We compiled data documenting community characteristics from 1990 to 2010, relying extensively on US Census Bureau, US Forest Service, USGS NLCD Land Cover, and ESRI data resources. We conducted all analyses using county-subdivision scale data to represent communities; this US Census Bureau geography represents towns, cities, and other forms of sub-county communities such as plantations and unorganized territories. We acquired US Census Bureau data from University of Minnesota's NHGIS (Manson et al., 2018) and selected particular economic and social variables based on prior work (Crandall & Weber, 2004; Morzillo et al., 2015).

We used data describing employment across major industry categories (agriculture, forest, fishing, hunting, & mining; construction; manufacturing; wholesale trade; retail trade; financial, insurance, & real-estate; service; and public administration); population levels and characteristics (unemployment rate, college education, age structure, poverty rate, median household income); and housing levels and characteristics (occupancy, vacancy, seasonal housing) in 1990, 2000, and 2010. For the cluster analysis, we calculated changes in the employment mix of community residents from 1990 to 2010 using information about changes in the percent of residents employed in eight distinct industry categories. For example, we

subtracted the percentage of community residents employed in manufacturing in 1990 from that same percentage in 2010 to describe the change in manufacturing employment.

We focused our analysis on information from the three most recent decadal censuses because of improved data reporting and more consistent census geographies over this time period as compared to prior decades. Using 2010 as our base year to select our subset of communities, we dropped observations (n=1,530) from the dataset if boundaries or identifiers were changed in years prior to 2010. We recognize the potential for biased results from these omissions and have prioritized additional data cleaning and sensitivity analyses for future work. As a result of such decision rules, our final sample consisted of 13,298 rural, forested communities for the exploratory analyses summarized in this paper (Figure 2).

Analysis

We conducted exploratory analyses to assess patterns in employment change across rural, forest-located communities. For this manuscript, we focused on changes in the percentage of residents employed in 8 industry categories from 1990 to 2010. We used non-hierarchical K-means (SAS 9.4 PROC FASTCLUS) to cluster or group our communities based on these changes in the percentage of employment by industry category (Afifi & Clark, 1996; James et al., 2013; Latting, Caroll, & Green, 2003). K-means groups observations into K distinct, non-overlapping classes by minimizing the variation within these clusters. The SAS PROC FASTCLUS procedure minimizes the sum of squared distances from the cluster means and assigns each observation into one cluster. We used Euclidean multivariate distance measures and ran the K-means procedure using pre-specified values for the number of clusters ranging from 2 to 10. We consulted various criteria (R-squared, CCC) and statistical test results, plotted key results by the number of clusters, and completed visual assessments to select the final number of classes. We assessed the sensitivity of results to using standardized or non-

standardized data and different initial seed values. Prior to conducting the cluster analyses, we examined patterns in the correlations among our input variables.

To better understand the differences among communities in each cluster, we compared socio-economic characteristics for each of the resulting community classes. We assessed differences in mean values by cluster and created various charts and plots (e.g., boxplots and kernel density and violin plots) to compare results visually. Together, these analyses document aspects of economic changes in rural, forest communities and initiate new thinking about how changes in employment of residents can lead to or be associated with different community outcomes.

Results

Sample

Data from the US Census Bureau reveal interesting changes in the mix of employment of residents across rural forested communities from 1990 to 2010 and variation in the socio-economic characteristics of rural forested communities (Tables 1 and 2, Figure 2). On average, the communities in our sample experienced reductions in the percentage of residents employed in manufacturing; agriculture, forestry, fishing, hunting, and mining; retail trade; wholesale trade; and public administration. Conversely, these communities experienced, on average, increases in the percentage of residents employed in service industries, construction; and finance, insurance, and real-estate industries (Table 1). On average population and housing levels, median household income, college educational attainment, and seasonal housing stock increased in our sample communities from 1990 to 2010 (Table 2). Over this same time period, the unemployment rate and senior citizen dependency ratio also increased on average in these rural, forested communities. In contrast, the poverty rate fell from 1990 to 2010 on average within our sample communities.

Cluster analysis

Based on various statistical and cluster analysis criteria, visual analyses, and review of the cluster means, we determined a 6-cluster solution was appropriate (Figures 3, 4, and 5). The number of communities assigned to each cluster varied, with more than half of the sample communities assigned to two clusters and the remaining split across four clusters (Figure 3). Key distinctions across the six clusters appear to follow from changes in the percent of employment in agriculture, forestry, fishing, hunting, and mining; manufacturing; retail trade; and service industries (Figure 4). On average, Cluster 1 was characterized by small changes in the mix of employment. In contrast, on average, Cluster 2 was characterized by moderate declines in the percent employed in agriculture, forestry, fishing, hunting, & mining; manufacturing; and retail trade sectors and by a sizeable increase in the percent employed by the service industry sector. On average, Cluster 3 was characterized by a balanced shift in the percent employed in distinct sectors, with moderate declines in the percent employed in manufacturing countered by moderate increases in the percent employed in service sectors. In contrast, Cluster 4, on average was characterized by a moderate reduction in the percent employed in the agricultural, forestry, fishing, hunting, and mining sector and corresponding moderate increase in the percent employed in the service sector. Cluster 5 on average was characterized by a moderate reduction in the percent employed in the retail trade industry and moderate increase in the percent employed in the service industry. Finally, Cluster 6 was characterized on average by marked (>20%) reductions in the percent employed in manufacturing and gains in the percent employed in the service industry. Overall, spatial patterns in these cluster assignments suggest considerable variation nationally and within regions (Figure 5).

Socioeconomic characteristics by cluster

Socioeconomic variation across the six clusters hints at potential associations between particular groupings of employment changes and socioeconomic characteristics (Table 3; Figure 6). Notably, Cluster 6 (defined by marked reductions in the percent employed in manufacturing industries and increases in the percent employed in service sector industries from 1990 to 2010) stands out, with the highest mean unemployment and poverty rates and lowest college attainment and median household income values of the six clusters in 2010. Conversely, the sample communities assigned to Clusters 1 and 5 with relatively smaller reductions in the percent employed in manufacturing industries and increases in the percent employed in service sector industries have the highest mean college attainment levels and median household incomes and lowest unemployment and poverty rates of the six clusters. These distinct trends perhaps not surprisingly suggest that less desirable socioeconomic outcomes could be associated with greater shifts in employment away from manufacturing and into service industries. While these correlative associations are of interest, they raise more questions than provide answers about the social and economic processes at work.

Discussion

Our results to date improve documentation of changing conditions in rural forest communities. These findings improve understanding of the ongoing economic transitions of rural forested communities and offer guidance for future theoretical and empirical work on community vulnerability and responses to shocks. By doing so, they guide future work by generating new research questions and directing research of structural relationships, and support ongoing community and economic development initiatives by helping to fill identified knowledge gaps about community change and economic transitions.

Notably, this research provided a means to reflect on our prior conceptual framework stressing three distinct trajectories characterizing the restructuring of community economies : production-shock-economic decline; production-shock-amenity development; and production-

shock-new forms of production (Morzillo et al., 2015), and to guide our future work integrating national, regional, and community data to (1) assess the nature and extent of economic shocks to rural forest-based communities and (2) characterize patterns in community responses to these shocks. More broadly, by furthering understanding of heterogeneity across these communities, we believe these results offer valuable guidance and insights for future research of changing rural forested communities.

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Figure 1.

Rural forested communities in the continental US (n=14,830)

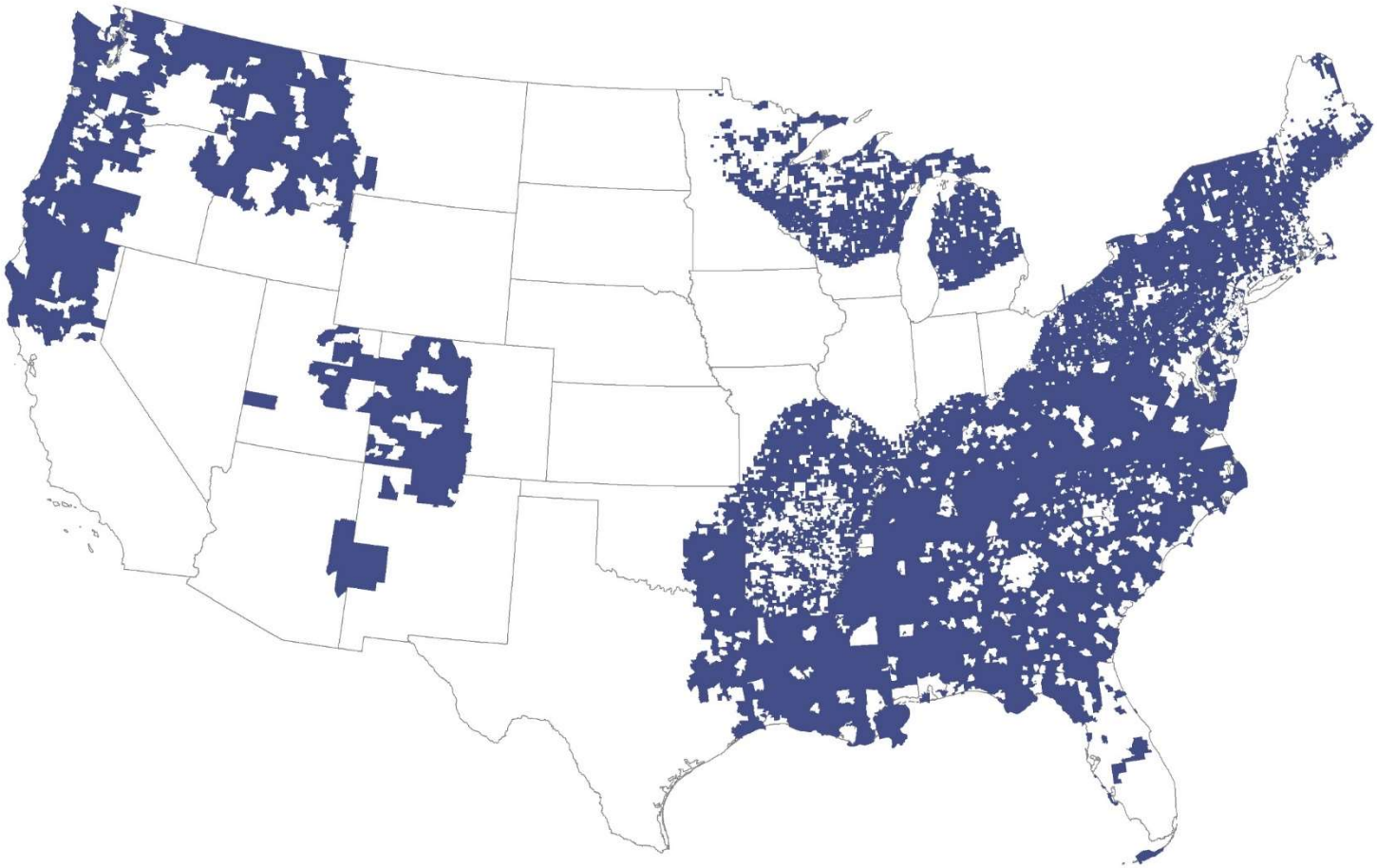
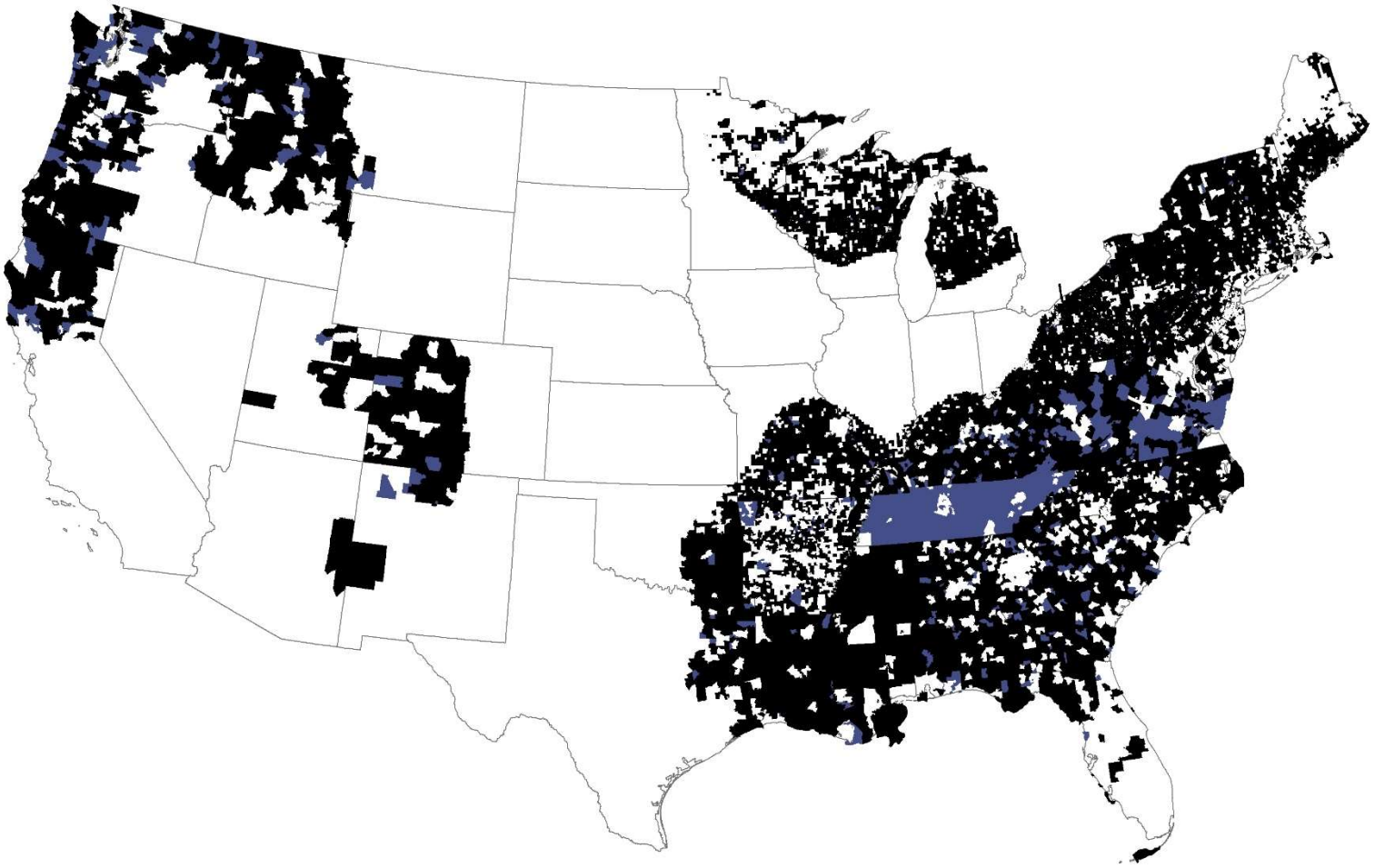


Figure 2.

Rural forested communities in the continental US (n=13,298)



* Darker areas comprise the final sample of communities used for the exploratory analyses (n=13,298 versus n=14,830)

Table 1. Change in Percentage of Residents Employed in Different Industries (1990 to 2010; n=13,298)

Variable	Description	Mean	Std Dev	Minimum	Maximum
CHAFFHM	Change in % of residents employed in agricultural, forest, fishing, hunting, and mining	-3.20	5.74	-45.29	55.83
CHCONSTR	Change in % of residents employed in construction	1.01	4.83	-44.81	39.93
CHMANUF	Change in % of residents employed in manufacturing	-8.13	8.29	-54.46	48.69
CHWTRADE	Change in % of residents employed in wholesale trade	-0.77	2.73	-20.40	38.27
CHRTRADE	Change in % of residents employed in retail trade	-4.04	5.99	-36.75	68.99
CHFINRE	Change in % of residents employed in finance, insurance, and real-estate	0.58	3.08	-15.44	32.34
CHSERV	Change in % of residents employed in service industries	14.62	8.48	-54.47	66.68
CHPUBADMIN	Change in % of residents employed in public administration	-0.52	4.34	-59.57	28.24

Table 2. Socio-economic characteristics of rural, forested communities (n=13,298)

Variable	Description	1990		2010	
		Mean	Std Dev	Mean	Std Dev
PAFFHM	% of residents employed in agricultural, forest, fishing, hunting, and mining	7.88	7.66	4.68	5.68
PCONSTR	% of residents employed in construction	7.74	3.59	8.75	4.77
PMANUF	% of residents employed in manufacturing	23.24	10.50	15.10	8.41
PWTRADE	% of residents employed in wholesale trade	3.40	2.10	2.63	2.23
PRTRADE	% of residents employed in retail trade	15.63	4.73	11.60	4.76
PFININRE	% of residents employed in finance, insurance, and real-estate	4.03	2.56	4.62	3.24
PSERV	% of residents employed in service industries	27.40	7.67	42.02	8.16
PPADMIN	% of residents employed in public administration	4.14	3.35	3.62	2.83
UNEMPLOY	Unemployment rate	7.20	4.25	9.11	5.04
PCOLL	% of adults with college degree	12.08	8.79	18.56	11.78
DEPRATIO	Dependency ratio	57.22	10.51	53.20	9.70
CHDEPRATIO	Children dependency ratio	34.99	6.71	28.35	5.97
SENDEPRATIO	Seniors dependency ratio	22.22	9.28	24.85	9.43
POVRATE	Poverty rate	14.78	9.75	14.44	9.08
MEDHHI	Median household income	25956.16	9599.31	49131.09	18243.20
POP	Population	3212.99	2941.73	3717.45	3332.80
HU	Housing units	1366.68	1231.61	1716.95	1521.76
PHUSEAS	% of Housing units that are seasonal	8.18	14.21	8.58	13.43

Figure 3. Changing Employment in Rural Forested Communities – Six Clusters (% of sample by Cluster)

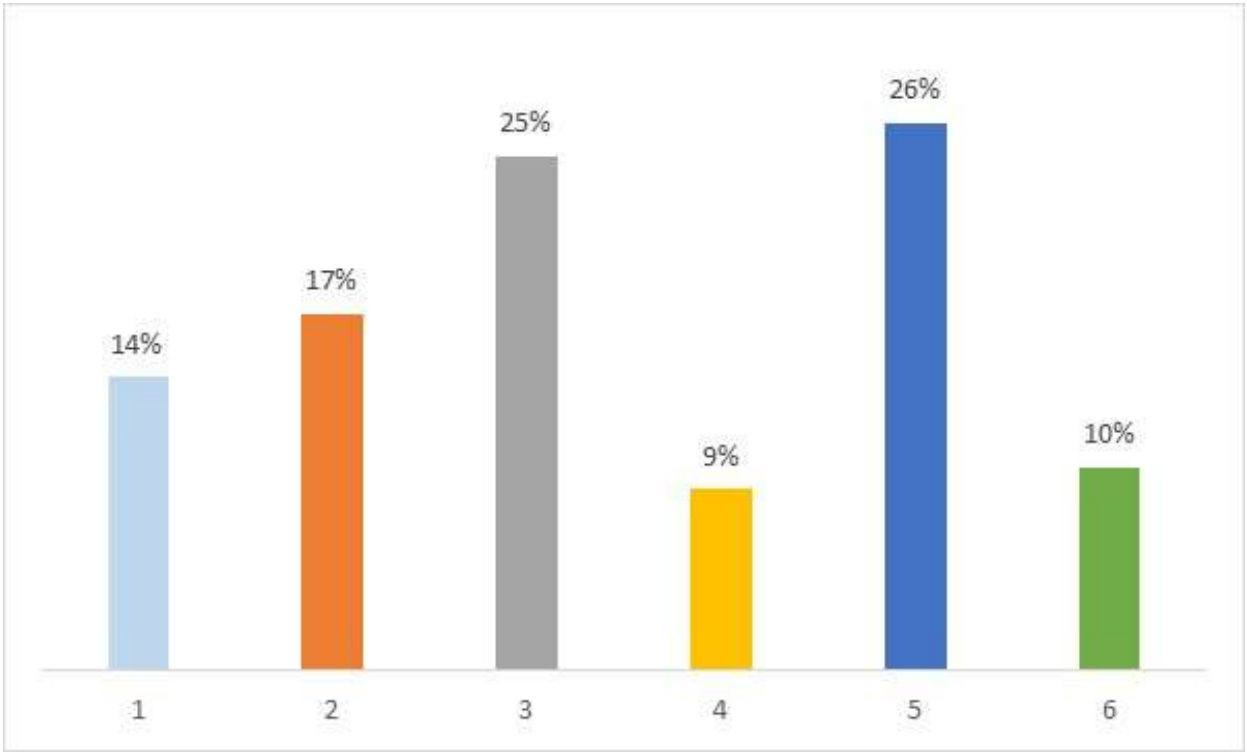


Figure 4. Mean Changes in Percent Employment by Cluster

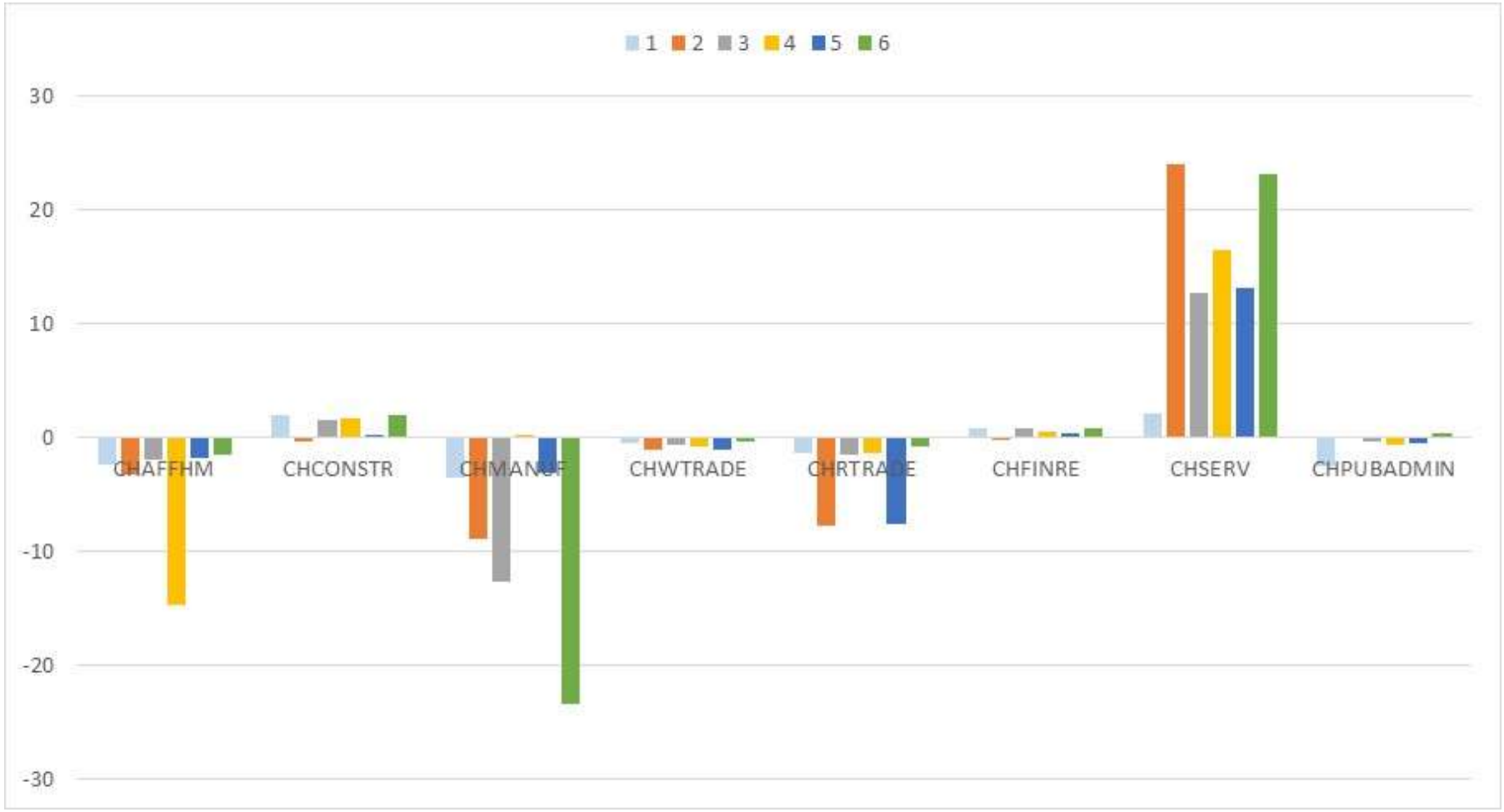


Figure 5. Spatial distribution of changing employment in rural forested community clusters

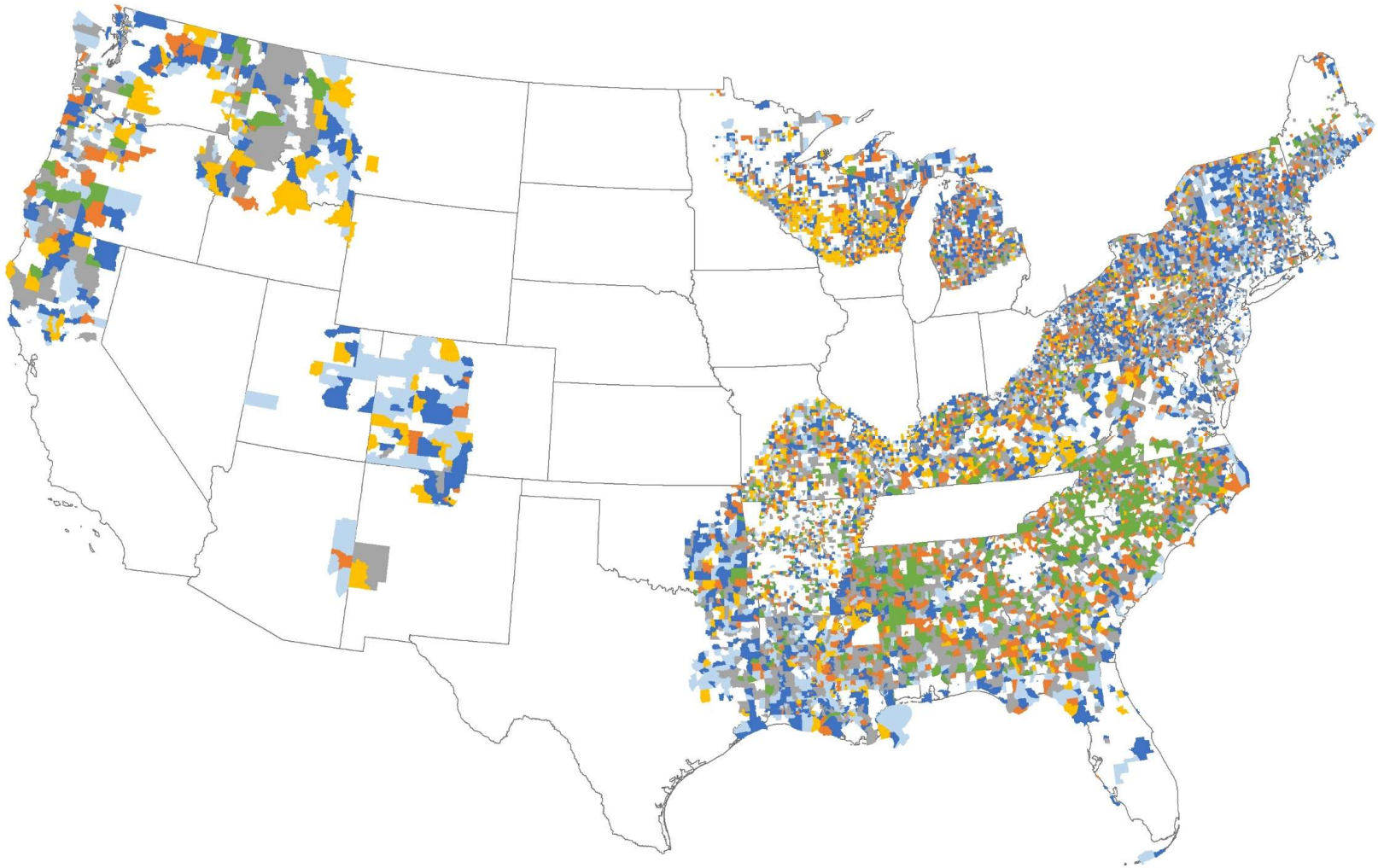
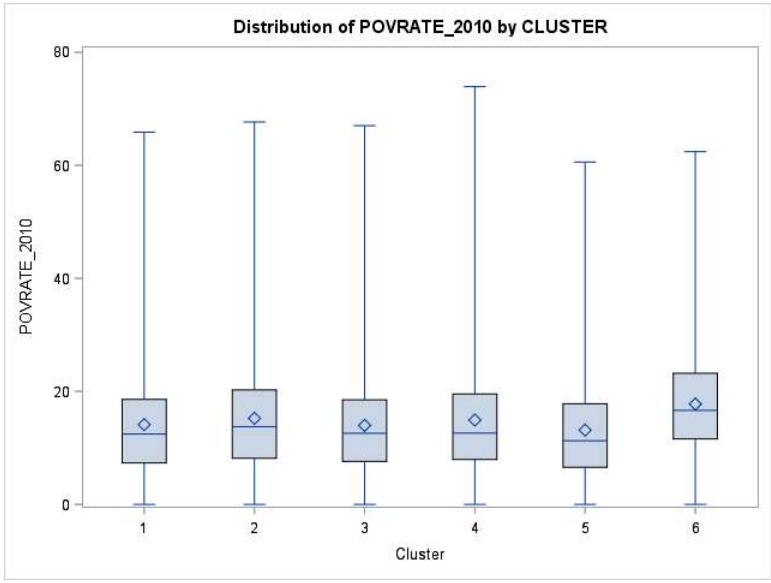
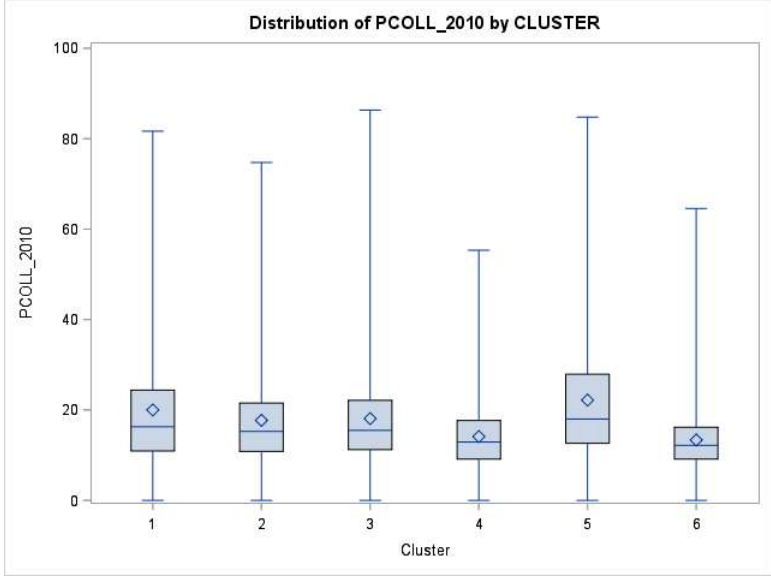


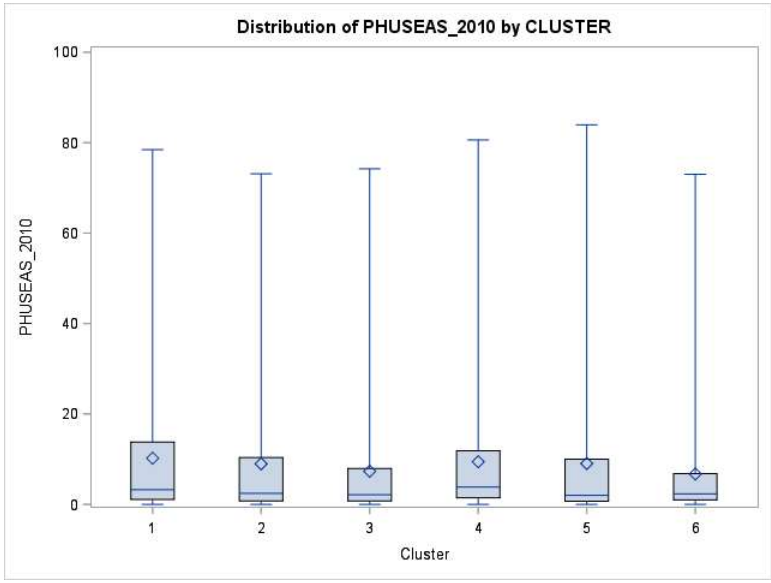
Table 3. Mean Socio-Economic Characteristics by Cluster (2010)

	UNEMPLOY	PCOLL	CHDEPRATIO	SENDEPRATIO	POVRATE	MEDHHI	POP	HU	PHUSEAS
1	8.58	20.00	27.92	25.48	14.11	51137.90	3204.58	1488.29	10.22
2	9.53	17.72	28.40	25.49	15.23	46622.41	3494.89	1635.29	8.98
3	9.18	18.09	28.26	23.99	13.99	49938.69	4067.34	1825.01	7.32
4	8.59	14.13	30.23	23.67	14.92	46981.05	1808.99	844.48	9.44
5	8.64	22.18	27.85	25.41	13.14	52776.43	4532.83	2120.27	9.04
6	10.73	13.36	28.80	24.49	17.76	40699.57	3471.94	1610.15	6.72

Figure 6 Socioeconomic characteristics by cluster (box plots)






Distribution of PHUSEAS_2010 by CLUSTER
PHUSEAS_2010
100
80
60
40
20
0
1
2
3
4
5
6
Cluster

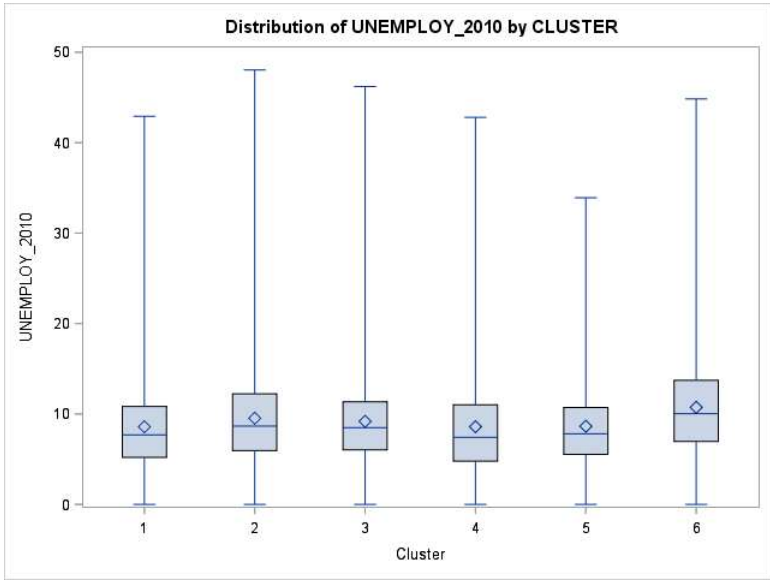

Distribution of UNEMPLOY_2010 by CLUSTER
UNEMPLOY_2010
50
40
30
20
10
0
1
2
3
4
5
6
Cluster

Figure 6 Socioeconomic characteristics by cluster (box plots) – continued