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The Role of Rural Areas in Regional Clusters: The Case of the Great Lakes Chicago EDA Region

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ABSTRACT

The cluster concept has dominated economic development practice for more than 20 years. In this article, we examine the mix of counties that play a significant role in various clusters, doing so by identifying their footprint or concentration of jobs. We begin by inspecting the performance of agriculture and manufacturing clusters in the Great Lakes Chicago Economic Development Administration's Region using the Purdue Cluster Classification typology and employing location quotients and spatial analysis. In general, the results suggest that most agriculture and manufacturing clusters in the Chicago Region became more concentrated across rural counties over the 2009 to 2019 period. We find that rural and urban areas have specific competitive advantages that can be important in guiding their economic development strategies. As the industry clusters cross administrative boundaries, cluster development strategies can have unique regional boundaries irrespective of state political jurisdictions. The results show that connecting sectors in corresponding economic areas may promote cluster-based economic development opportunities and specialization. Several regional policy implications emerge from the findings.

INTRODUCTION

Traditionally, local and regional officials strived to diversify their local economies in order to protect jobs and the tax base against economic shocks (Neffke et al., 2018; Cainelli and Iacobucci, 2015). More recently, economic development practitioners have considered different concepts, such as competitiveness and the role of industry clusters, as an option to advance the economic health of a region. Clustering has been a viable strategy since it appeared in the literature more than 20 years ago (Porter, 1998). This concept focuses on attracting and enabling the local companies that contribute to a

value chain. Simultaneously, the value chain serves one industry or a small number of interdependent industries. An industry cluster strategy is efficient as it allows economic development resources to concentrate on a specific, well-defined target. In his study, Porter (2003) defines clusters as a geographically adjacent group of interlinked businesses, service providers, suppliers, and associated institutions operating in a particular field, connected by various types of standard features such as skills, knowledge, technologies, and inputs.

However, what is less well known is whether rural areas can play a vital role in contributing to various industry clusters. It might be argued that rural areas need to collaborate with their surrounding urban and suburban communities in order to play a role in building strong, vibrant regional economies. If their engagement is vital, then what opportunities exist to strengthen rural areas' ties to other industries in the future? Porter (2003) points out that the economic performance of rural areas can be strengthened by connecting with regional industry clusters. Rural areas have always had some tie to urban areas, but in an age where urbanization has accelerated the movement of people and jobs to large, populated places, the question is, "do rural areas still matter"?

It is worth noting that an industry cluster might be urban or rural-centric, depending on the geographic location and industry sectors that constitute the cluster. If the clusters are relatively more concentrated in rural areas, they are rural-centric clusters and vice versa for the urban-centric clusters. Such patterns can support the hypothesis that cluster-based economic development strategies are not limited to urban and metropolitan regions. If this happens to be the case, then rural regions should take note of the advantages associated with the pursuit of cluster-based regional competitiveness strategies.

The overall purpose of this article is to assess the regional economic competitiveness of rural areas to support growth and development strategies. Thus,

STUDY BACKGROUND

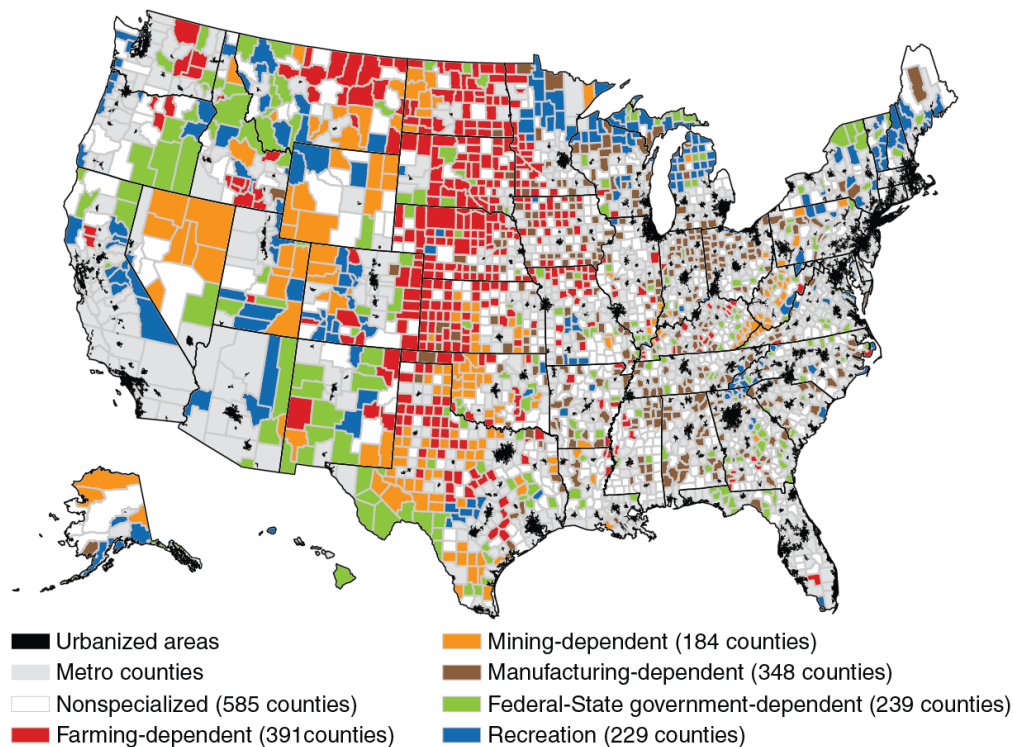
Cluster Structure in the Great Lakes Region

General Cluster Concept

Rural areas are economically diverse (e.g., Neffke et al., 2011; Phillips, 2014). Most rural counties offer employment in a variety of industries, but their industry mix differs (USDA, 2016). According to six mutually exclusive categories of economic dependence, the 2015 ERS County Typology Codes classify all U.S. counties as farming, mining, manufacturing, Federal/State government, or recreation dependent, along with a nonspecialized category (Figure 1) (ERS, 2015). Local economies are more sensitive to economic trends that have a pronounced effect on their leading industry sectors. For example, trends in agricultural prices have a disproportionate impact in farming-dependent counties. Or the boom in U.S. oil and natural gas production tends to have major impacts on mining-dependent counties (ERS, 2015).

our intent is to determine the nationally competitive strengths of clusters that are constituted, in large part, of rural areas. Specifically, we examine the following research question: “What are the linkages between cluster structure, cluster performance, and degree of rurality?” We evaluate the mix of counties that play a significant role in various clusters by identifying their footprint¹ or concentration of jobs. We do so by studying the performance of agriculture and manufacturing clusters across the six states that constitute the Great Lakes Region, a geographic area that aligns with the Economic Development Administration’s (EDA) Chicago Region. We examine the location quotient for all pertinent clusters to understand the nature and level of changes they have experienced over the 2009 to 2019 period. Lastly, we employ spatial analysis to determine the geographical concentration of the two clusters. The following sections offer a more detailed description of clusters, the main study area, our methodology and data collection, the spatial analysis, and a presentation of results and their implications.

Figure 1 - Rural counties vary in their economic structure with marked regional differences



Note: The 2015 county typologies use data from 2010-2012

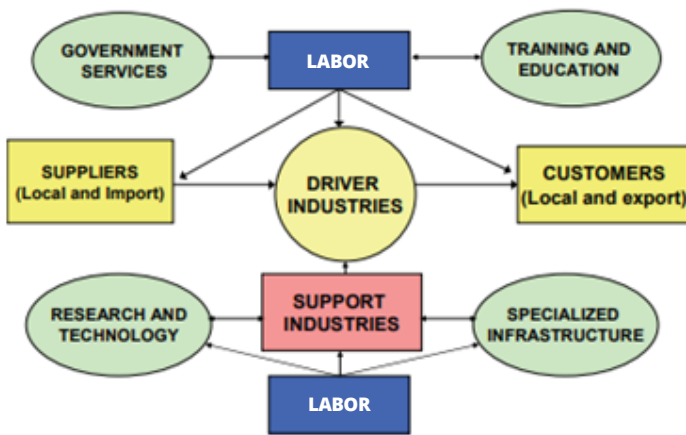
Source: USDA, Economic Research Service using data from the Bureau of Economic Analysis

1. Footprint can be defined as a presence of an industry cluster assessed not via number of jobs but through the concentration of jobs with respect to a benchmark such as the national average.

Industry clusters are regional concentrations of competitive firms that include high and low value-added employment, produce products for exports outside the region, and essentially drive the creation of the region's wealth (PCRD, 2007). Industries that belong to the same cluster require similar supporting services, institutional support, and specialized infrastructure (PCRD, 2007). An industry cluster network brings a diverse group of firms and institutions working synergistically and benefits from knowledge spillovers and innovation. It is not uncommon for metropolitan regions with competitive industry clusters to produce mutually beneficial spatial spillovers to their adjacent rural areas.

Figure 2 provides a schematic of an industry cluster, one that includes significant supply chain, value chain, and institutional linkages. It shows that industry clusters are complementary groups of businesses and industries that buy and sell from each other, use similar technologies, share supply chains and labor pools, require similar skills, and more importantly, share, leverage, and promote innovation (PCRD, 2007).

Figure 2 - A generalized concept of industry clusters



Source: PCRD, 2007

Cluster Structure in the Great Lakes Region

This section describes a structure of clusters located in the Great Lakes EDA Chicago Region (Great Lakes Region), the study area for our research. EDA is a federal government agency that plays a crucial role in facilitating regional economic development. Great Lakes Region encompasses the six states of Illinois, Indiana, Michigan, Minnesota, Ohio, and Wisconsin (Figure 3). Collective, the six states have a total population of 52,542,063 (as of 2019).

Figure 3 - The U.S. Economic Development Administration Regions



Source: U.S. Economic Development Administration, www.eda.gov

Clusters can be divided into two groups based on the location they serve – local clusters and traded clusters. Local clusters consist of industries that serve the local market. They dominate in each regional cluster, no matter the competitive advantage of a location. In contrast, traded clusters represent a group of related industries serving markets beyond the region in which they are located. Table 1 shows the list cluster of economic areas² in the Great Lakes Region and the states each economic area encompasses.

2. Based on the U.S. Bureau of Economic Analysis definition, “economic areas define the relevant regional markets surrounding metropolitan or micropolitan statistical areas. They consist of one or more economic nodes—metropolitan or micropolitan statistical areas that serve as regional centers of economic activity—and the surrounding counties that are economically related to the nodes. These economic areas represent the relevant regional markets for labor, products, and information. They are mainly determined by labor commuting patterns that delineate local labor markets and that also serve as proxies for local markets where businesses in the areas sell their products. In less populated parts of the country, newspaper readership data are also used to measure the relevant regional markets” (BEA, 2004).

Table 1 - Cluster Economic Areas in Great Lakes Region

Cluster Economic Area	States
Chicago-Naperville-Michigan City	IL-IN-WI
Cape Girardeau-Jackson	MO-IL
Champaign-Urbana	IL
Davenport-Moline-Rock Island	IA-IL
Paducah	KY-IL
Peoria-Canton	IL
Springfield	IL
St. Louis-St. Charles-Farmington	MO-IL
Cincinnati-Middletown-Wilmington	OH-KY-IN
Evansville	IN-KY
Fort Wayne-Huntington-Auburn	IN
Indianapolis-Anderson-Columbus	IN
Louisville-Elizabethtown-Scottsburg	IN
South Bend-Mishawaka	IN-MI
Alpena	MI
Detroit-Warren-Flint	MI
Grand Rapids-Muskegon-Holland	MI
Marinette	MI-WI
Traverse City	MI
Duluth	MN-WI
Fargo-Wahpeton	ND-MN
La Crosse	WI-MN
Minneapolis-St. Paul-St. Cloud	MN-WI
Cleveland-Akron-Elyria	OH
Columbus-Marion-Chillicothe	OH
Dayton-Springfield-Greenville	OH
Toledo-Fremont	OH
Milwaukee-Racine-Waukesha	WI
Appleton-Oshkosh-Neenah	WI
Madison-Baraboo	WI
Wausau-Merrill	WI

Source: Cluster Mapping, <http://clustermapping.us/region>

Note: Cluster Mapping Project uses BEA's economic areas.

To better understand how clusters work, **Figure A1** in the Appendix displays the Chicago Economic Area called Chicago-Naperville-Michigan City that encompasses the states of Illinois, Indiana, and Wisconsin (IL-IN-WI). The IL-IN-WI Economic Area consists of 64% of local clusters and 36% of traded clusters. The traded clusters portfolio involves the eight strongest Harvard industry clusters in this region based on the employment specialization in a region, namely: Education and Knowledge Creation; Financial Services; Marketing, Design and Publishing; Metalworking Technology; Upstream Metals Manufacturing; Printing Services; Downstream Chemical Products; and Environmental Services.³

METHODOLOGY

Data Collection

Our study area consists of all 524 counties that are part of the Great Lakes Region. To examine data on the county level, we used the Purdue Industry Clusters database with clusters defined at the six-digit NAICS (North American Industry Classification System) level. The definitions overlap in some cases since some specific industry sectors are likely to contribute to more than one industry cluster.⁴

Given our interest in rural regions, it was important to determine which of the various urban and rural classification systems employed in the U.S. would be the best fit for our study. We considered the Economic Research Services' Rural-Urban Continuum and Urban Influence codes; the Metropolitan, Micropolitan, and Noncore designations released by the Office of Management and Budget and the U.S. Census Bureau; the Rural-Urban designation developed by the U.S. Census Bureau; and the Index of Relative Rurality (IRR) produced by Waldorf at Purdue University. The IRR is a continuous measure of rurality with values between 0 and 1 (Waldorf, 2007; Waldorf and Kim, 2018). Higher IRR values show more rural counties, whereas lower values show less rural or urban-oriented counties (Waldorf, 2007). Because of the continuous nature of the IRR, we opted to adopt this

3. Cluster Mapping, http://clustermapping.us/region/economic/chicago_naperville_michigan_city_il_in_wi/cluster-portfolio#employment.

4. The industry clusters and their constituent industry sectors are available at http://www.statsamerica.org/innovation/reports/detailed_cluster_definitions.pdf.

typology for our analysis. The measure is based on the following variables: logarithm of population size, the logarithm of population density, network distance, and urban area as a percentage of total land area.

Location Quotient

The Location Quotient (LQ) is an important tool that evaluates the strength and size of a particular industry or a cluster in a region relative to the national average. The existence and strength of a regional cluster are conditional on having a higher concentration of activity in the cluster when contrasted to the national average:

$$\text{Location Quotient} = \frac{\text{Regional Industry Concentration}}{\text{National Industry Concentration}}$$

Whenever $LQ > 1$, a particular industry is more localized or concentrated in the region than in the nation. If a particular industry is less concentrated in the region than in the nation ($LQ < 1$), it is considered less capable of satisfying regional demand for its output. Based on data availability, different regional and national economic activity measures are often used (Miller and Blair, 2009). We calculate industry LQs by comparing the industry's share of regional employment with its share of national employment. Strong clusters are defined as those where the location quotient, or the relative employment specialization of a cluster, places them among the top 25% of regions in this given cluster category in the nation. For example, if commercial breweries in a region account for 8% of all jobs, but they account for 5% of all jobs in the U.S., then the LQ for breweries in the region is $(0.08/0.05) = 1.6$. This means that the breweries in the region are 1.6 times more concentrated than the rest of the nation, on average. Or suppose in Butte, MT, mining in a local region has an LQ of 5.9. This indicates that mining is nearly six times more concentrated in this area than in other areas in the U.S. As a result, mining represents a vital component of the Butte economy (EMSI, 2021).

Spatial Analysis

The industry clusters data are compiled at the county level and converted for Geographical Information System (GIS) usage. The GIS-based feature classes and shapefiles are common for mapping and exploratory spatial data analysis. We employ different types of mapping, such as non-parametric⁵ Kernel density mapping and multiple attribute⁶ thematic maps. Kernel density mapping is a type of hot-spot analysis. Multiple attribute mapping means placing more than one attribute, such as level and change, simultaneously on the map. Also, we perform the spatial analysis using the first-order and second-order spatial effects⁷, including the Nearest Neighborhood Ratio and global and local spatial autocorrelation indices. Such analyses uncover clustering or dispersal patterns over space and indicate if there are co-dependencies over space or geography that are affected by its neighbors. The purpose is to show clustering patterns visually and statistically.

The spatial analysis investigates the concentration and dispersal of industry clusters in the Great Lakes Region. Our objective is to identify locations in the Great Lakes Region where specific industry clusters are specialized and concentrated. This means that our interest is not only a county having a location quotient (LQ) value of 1.2 or higher in a specific industry cluster but so its neighboring counties. Note that the Economic Base theory states "specialization" as an LQ value of 1.0 and higher or concentration of jobs in the cluster is the same as the nation. For this report, we use the specialization cut-off as an LQ value of 1.2 or a concentration of employment is at least 20% higher than the national average. This value is obtained from the field observations and review of the past literature (PCRD, 2007; Nolan et al., 2011; Kumar et al., 2017).

Results

Having identified regions where the spatial distributions of industry clusters are determined to be concentrated, the next obvious question is the statistical validity of

5. Non-parametric method differs from the classical parametric method by not assuming the distribution function beforehand. In general, classical parametric method assumes normal distribution.

6. Developing maps of more than one attribute simultaneously.

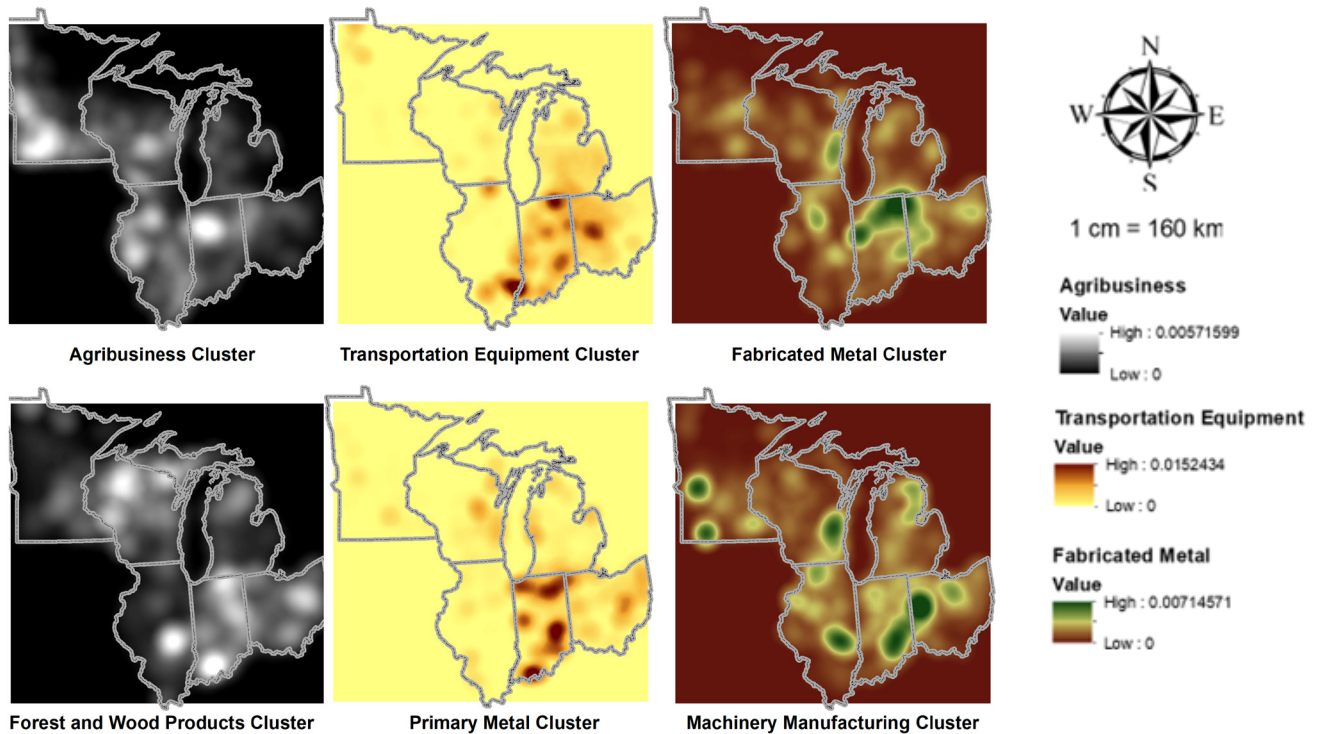
7. First-order deals with mean or expected outcomes. Second-order deals with correlation.

those patterns. We use various types of mapping, such as Kernel density and Multi-attribute mapping, and spatial statistics, such as the Nearest Neighbor Index and global/local spatial autocorrelation indices and bivariate plots to determine unique spatial patterns and their statistical significance. The Kernel density mapping in **Figure 4** shows the heat maps of LQ values for the six industry clusters as defined by Purdue University. These maps use LQs instead of the total jobs in these clusters to account for different types (rural/urban, non-metro/metro, large/small) of counties. It can be observed that agribusiness and forest and wood products, two primary industry clusters, have unique spatial footprints. Agribusiness is highly concentrated in north-central Indiana, southwest Minnesota, southern and central Wisconsin, northwestern Illinois, and parts of Ohio and Michigan. The geographical pattern for Forest and Wood Product cluster reveals well-known concentrations in southern and northeastern areas of Indiana, eastern Ohio, east-central Illinois, and northern Wisconsin and Michigan. Proximity to forests and nature reserves can explain, in part, the concentration of Forest and Wood Product industries in these locations.

The durable manufacturing-based industry clusters, such as the transportation equipment, primary metal, and machinery manufacturing clusters, reveal distinct patterns of specialization over the Great Lakes Region. The maps uncover why manufacturing is significant to Indiana's economy. The transportation equipment cluster, which primarily contains automotive, truck, and other vehicle manufacturers and suppliers, is concentrated around manufacturers in Detroit, Subaru, and Wabash National in the Greater Lafayette IN area, Toyota in southern Indiana, and Honda in eastern Indiana and western Ohio. The multi-attribute mapping (**Figure 5**) captures the 2019 LQ values and the percent changes in LQ values between 2009 and 2019. A positive percent value (orange and blue colors) means that the LQ (or concentration) has increased in the ten-year interval (2009-2019). A large number of counties observed up to a 25% increase in their LQ values for specific industry clusters, as evident from the distribution of orange-colored dots on the maps.

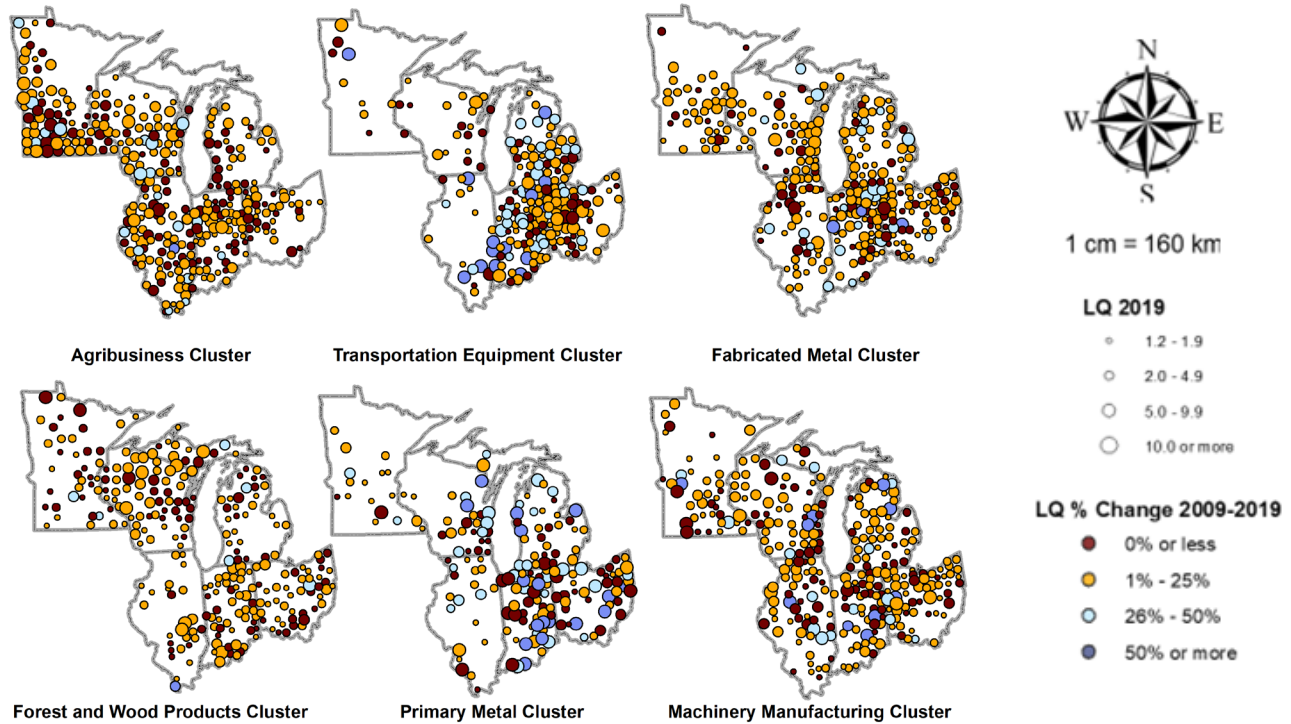
In contrast, increases in LQ values by 26% -50% and 50% or more are less evident. Exceptions include primary

Figure 4 - Kernel Mapping of Industry Cluster LQ, 2019



Note: Authors used ArcGIS, EMSI, and Purdue cluster definitions

Figure 5 - Multi-attribute Mapping of Industry Clusters



Note: Authors used ArcGIS, EMSI, and Purdue cluster definitions

metal cluster, where few counties in southern Indiana, coastal areas in Michigan, and Wisconsin had more than a 25% increase in LQ values. Rural areas of South Bend and Evansville metros areas observed 50% or more growth in LQ values in the primary metal cluster from 2009 to 2019. Northwestern Indiana, a well-known concentration of steel industries, observed a decline in the LQs of a primary metal cluster from 2009 to 2019.

Mapping can visually reveal clustering patterns, but then spatial statistics can determine the statistical significance of those patterns. The Nearest Neighbor is a clustering measure with a value less than, equal to, or greater than 1, where smaller values than 1 show clustering and a larger value than 1 show dispersal. The Nearest Neighbor Ratio is estimated for counties that have specialization or LQ values of 1.2 or higher. In general, counties having industry clusters with LQs greater than or equal to 1.2 reveal specialization and concentrated employment. Here, the Nearest Neighbor shows if specialized counties are in geographical proximity. The agribusiness, forest and wood products, fabricated metal, and machinery manufacturing clusters have statistically significant

values of the Nearest Neighbor Ratio and reveal marginal dispersal pattern contrary to the expected clustering pattern (Refer to Table 2).

To further uncover the concentrations and co-locations of industry clusters over space, we employ the Moran's I global and local spatial autocorrelation indices. It required delineating the neighborhood scheme. Here, we use the Queen 1st Order Contiguity, where the first immediate neighbors, irrespective of the cardinal directions, are part of the neighborhood matrix. Table 3 reveals that the agribusiness and forest and wood products cluster had global Moran's I values of more than 0.3 and 0.2 for 2001, 2009, and 2019, respectively. These values are decent and show clustering of high-high or low-low values of LQs across the Great Lakes Region. Transportation equipment and fabricated metal clusters also have reasonable values close to 0.2 but exceeded 0.2 for transportation equipment cluster only in 2001. All these values are statistically significant, which means the spatial pattern cannot result from a random chance. Note that autocorrelation indices are robust in delineating spatial clustering compared to the Nearest Neighbor analysis.

Table 2 - Significant Nearest Neighbor Index for Select Industry Clusters

Cluster Name	Nearest Neighbor Ratio	P-value
Agribusiness	1.097683	0.000798
Forest & Wood Products	1.079277	0.014465
Fabricated Metal	1.114533	0.000140
Machinery Manufacturing	1.121214	0.000068

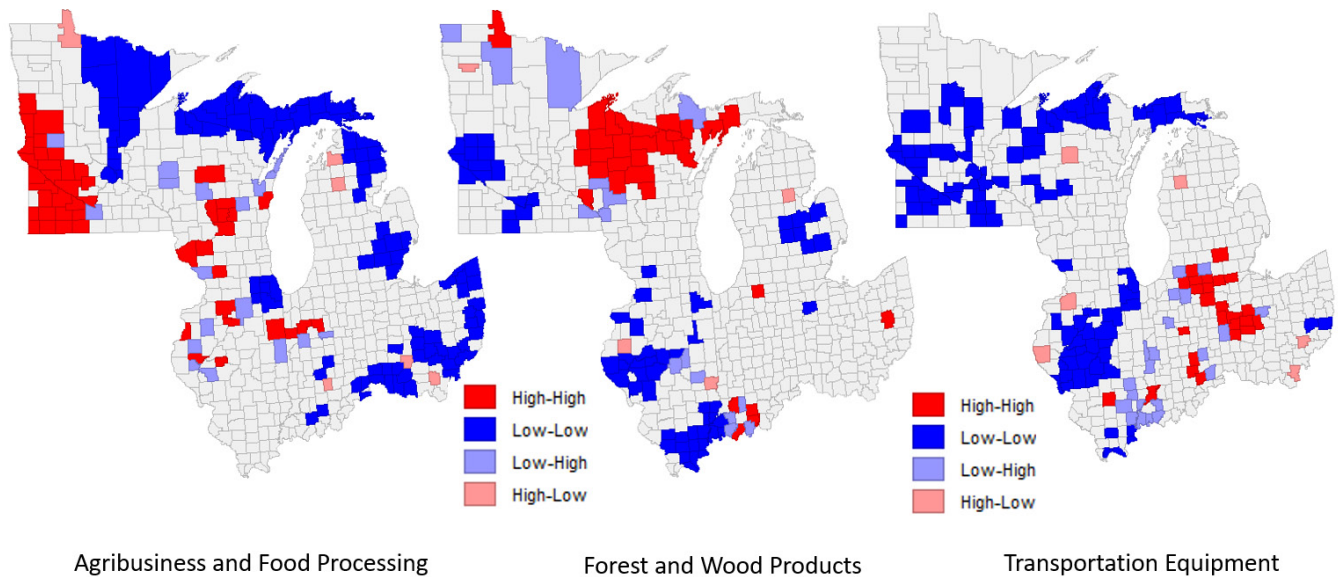
Note: Authors used ArcGIS, EMSI, and Purdue cluster definitions

Table 3 - Global Moran's I Values for Selected Industry Clusters

Moran's I	2001	2009	2019
Agribusiness	0.328	0.342	0.340
Forest & Wood Products	0.210	0.201	0.206
Transportation Equipment	0.212	0.169	0.131
Fabricated Metal	0.194	0.174	0.184

Note: Authors used GeoDa (Anselin, Syabri, and Kho 2006), EMSI, and Purdue cluster definitions

Figure 6 - Selected Industry Clusters Local Moran's I of LQ 2019



Note: Authors used GeoDa (Anselin, Syabri, and Kho 2006), EMSI, and Purdue cluster definitions

Similar to the correlation coefficient, global Moran's I values vary between -1 and +1, where positive values show clustering and negative values show dispersal. Compared to the global Moran's I, the local Moran's I can delineate the clustering and dispersal at the local level. The Great Lakes Region has six states and more than five hundred counties. Hence, there can be several local-level

geographical clusters in the Great Lakes Region. Figure 6 reveals such patterns of high-high and low-low LQ values in the agribusiness, forest and wood products, and transportation equipment clusters for 2019. These maps, also known as hot-spot and cold-spot mapping, can be used for targeted place-based economic development.

Figure A2 in the Appendix reveals that the agribusiness clusters are co-located and more concentrated in counties with higher Index of Relative Rurality (IRR) values. As noted earlier, the IRR is a continuous measure of rurality with values between 0 and 1 (Waldorf 2007, Waldorf and Kim 2018). Higher IRR values show more rural counties, whereas lower values show less rural or more urban-oriented counties (Waldorf 2007). The agribusiness and forest and wood products clusters are rural-centric. On the other hand, primary metal, computer and electronic, and electrical equipment and appliance manufacturing clusters are relatively more urban-oriented. Machinery manufacturing seems to be located and concentrated in both urban and rural areas. As such, the general belief that rural areas cannot benefit from cluster-based competitiveness strategies is not entirely correct in the Great Lakes Region.

CONCLUSION

This study examined how to ensure that rural areas are not left behind in building a more diverse and robust economy. One way they do so is to be better connected to those regional clusters in which they are embedded. The specialization footprints reveal that strategies for industry cluster-based development need to consider place-based approaches. After examining the employment pattern across the Great Lakes Region in many industries, we found out that manufacturing, agribusiness and food processing, and forest and wood product clusters have specific co-locations and geographical clustering patterns in the region. Contrary to the general notion, select industry clusters are rural-centric with higher LQ values in more rural areas. On the other hand, there are urban-centric manufacturing clusters, such as computer and electronic product manufacturing.

Our results show that rural and urban areas have specific competitive advantages. More importantly, rural areas can participate in industry cluster-based economic development initiatives. A large portion of the literature argues that cluster-based strategies are more suitable for metropolitan and urban regions. In contrast, researchers have recently explored the synergies between rural and urban areas to promote cluster-based economic development opportunities and the advantages of having

specialization at the county and larger region levels. In this study, the industry clusters of higher and lower concentrations are geographically co-located, revealing hot-spots and cold-spots mapping patterns both in urban and rural areas. Interestingly, these areas cross administrative boundaries, such as state lines. Hence, cluster development strategies can have unique regional boundaries irrespective of state boundaries.

Industry cluster-based economic development requires cluster coordination, nurturing, acceleration, and partnerships across industry groups and jurisdictions. Intergovernmental coordination and cooperation provide major support to cluster development, which is necessary if clusters are concentrated across the administrative and political jurisdictions.

The mix of clusters and their performance vary markedly across the Great Lakes Region. Our findings highlight the importance of regional economies and the need to decentralize economic development policies to the regional level. Rural regions should focus on upgrading rural-urban cluster connections in which they have a meaningful position. Many rural economies are not dependent only upon agriculture but have clusters of strength in nonagricultural sectors, such as machine manufacturing. Local or regional policies should concentrate on the existing regional specialization that national policies cannot effectively address or support.

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Figure A1 - Cluster Mapping of Chicago Economic Area

Cluster Specialization

- Strong clusters above 90th percentile specialization
- Strong clusters above 75th percentile specialization
- Other specialized clusters (LQ > 1.0)

- BCR >= 95th ptile & RI >= 20%
- BCR 90th-94th ptile & RI >= 20%
- Next closest clusters not meeting above criteria

Source: Cluster Mapping http://clustermapping.us/region-cluster/agricultural_inputs_and_services/economic_chicago_naperville_michigan_city_il_in_wi

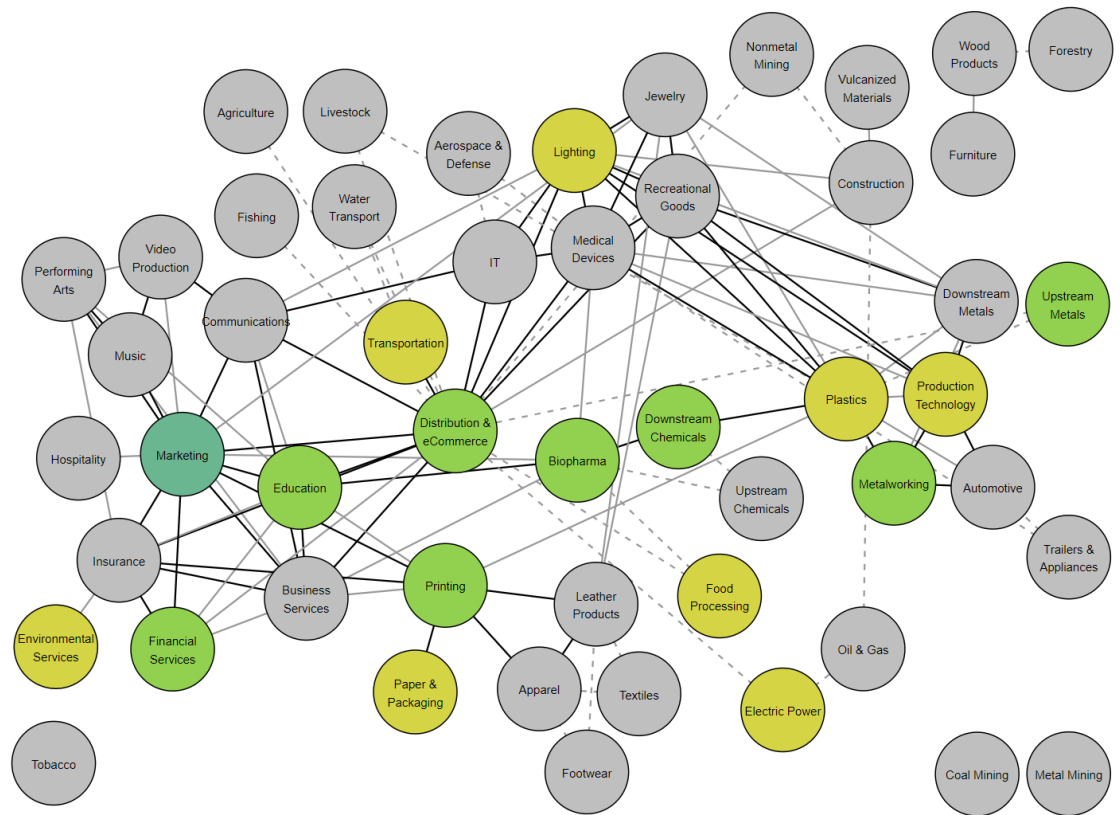
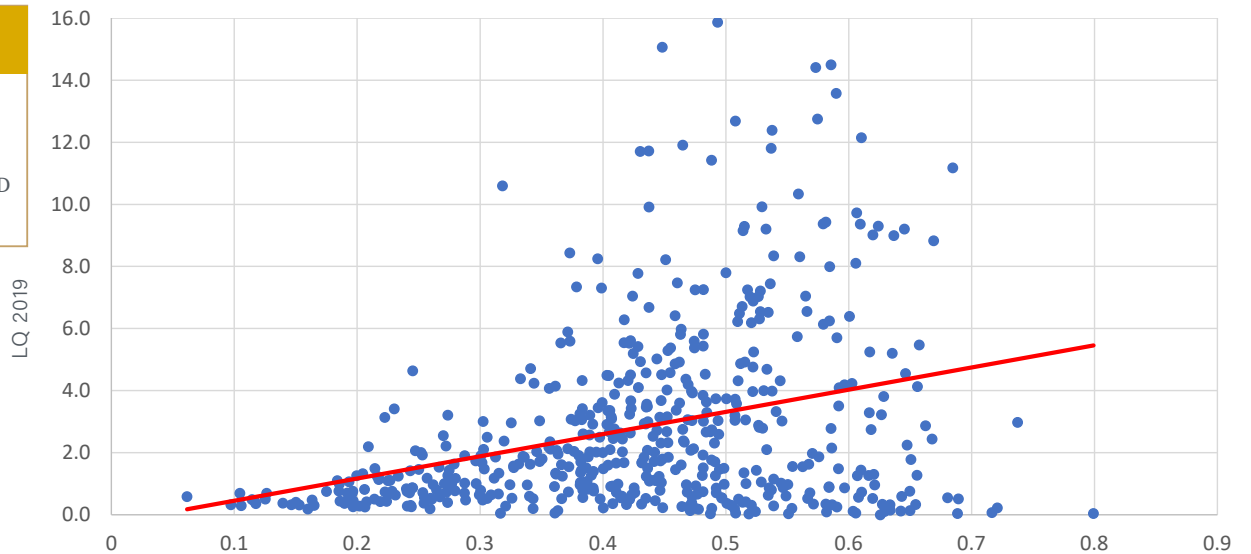


Figure A2 - Scatter Plots of Industry Cluster LQ 2019 and IRR 2010

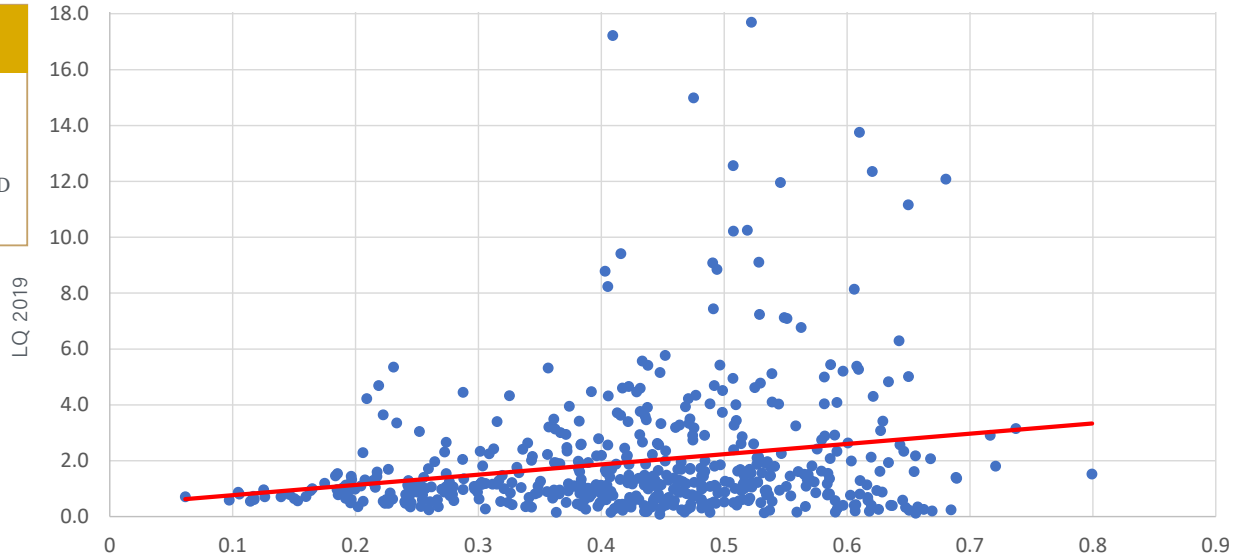
Agribusiness and Food Processing

Note: Horizontal axis is the Index of Relative Rurality (IRR). Based on PCRD (2007).



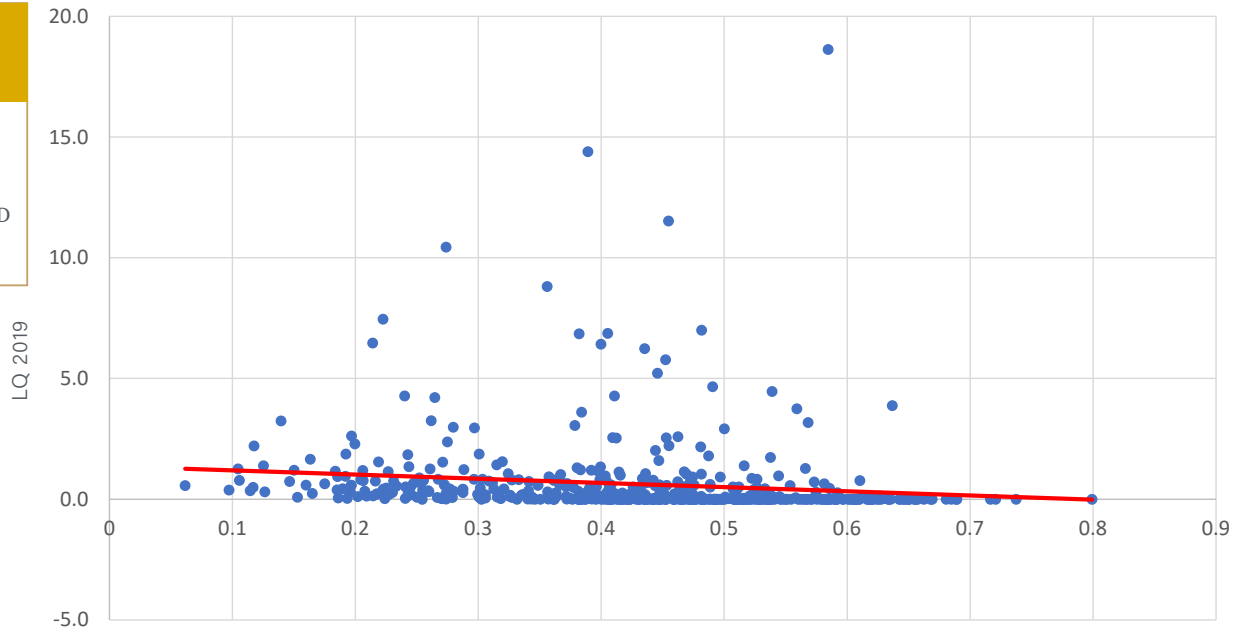
Forest and Wood Product

Note: Horizontal axis is the Index of Relative Rurality (IRR). Based on PCRD (2007).



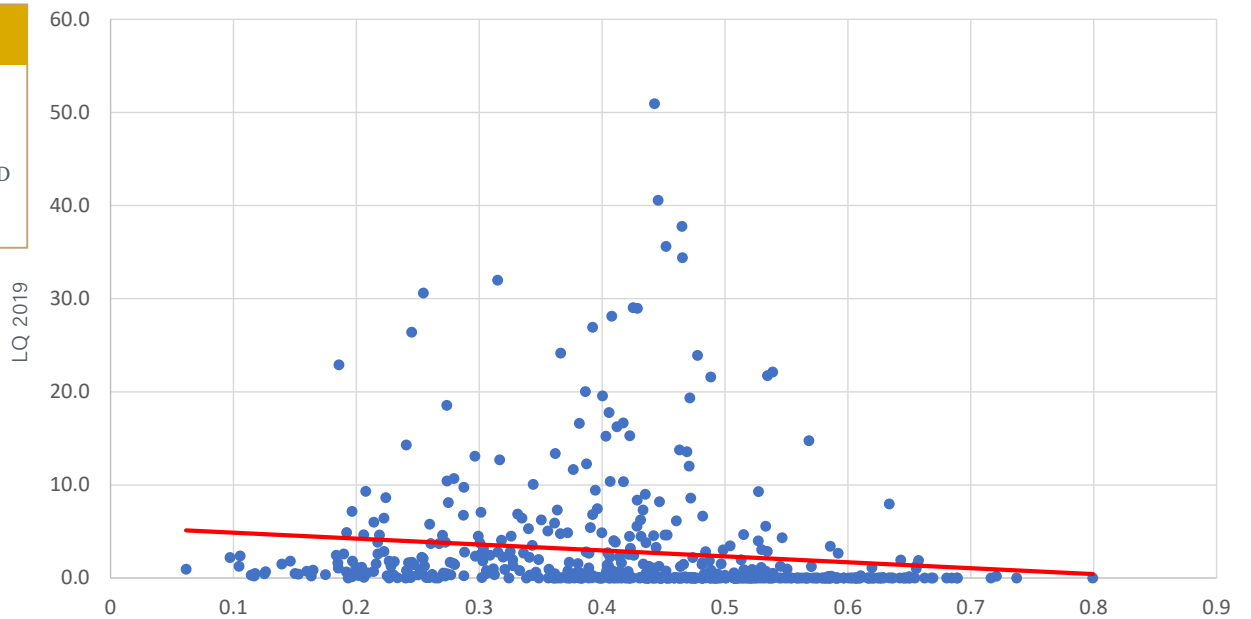
Computer and Electronic Products

Note: Horizontal axis is the Index of Relative Rurality (IRR). Based on PCRD (2007).



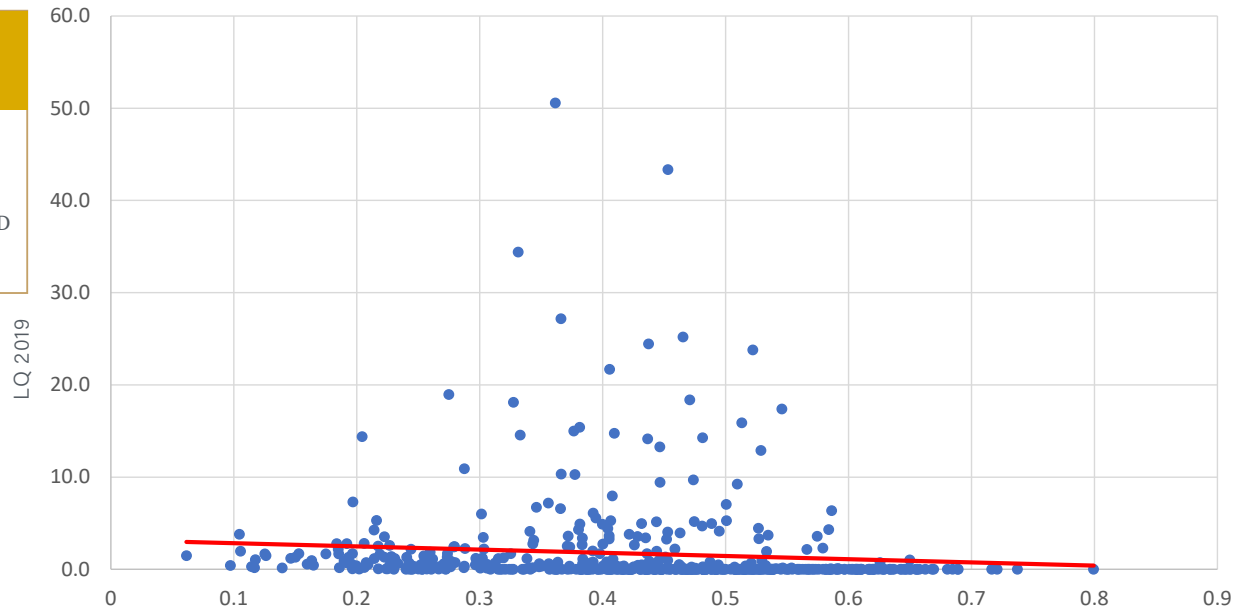
Primary Metal

Note: Horizontal axis is the Index of Relative Rurality (IRR). Based on PCRD (2007).



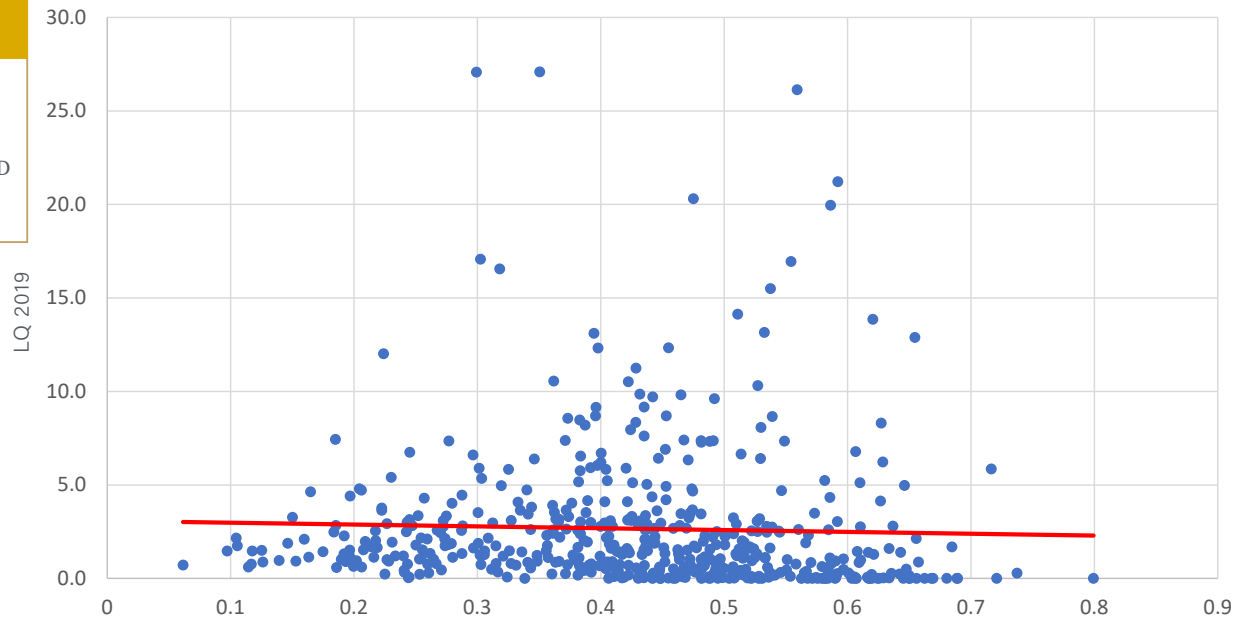
Electrical Equipment & Appliance

Note: Horizontal axis is the Index of Relative Rurality (IRR). Based on PCRD (2007).



Machinery

Note: Horizontal axis is the Index of Relative Rurality (IRR). Based on PCRD (2007).



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