The Rural Role in National Value Chains and Regional Clusters

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Summary: The fullest understanding of the implications of industrial interdependence for rural economies requires viewing clusters on a spatial continuum, from those that are national or even global in geographic scope to those that are highly localized in specific places. Rural economies may depend on, and contribute to, the competitive success of clusters anchored elsewhere. A search for strictly locally-based clusters, or even those nearby that spill into rural communities, understates the rural role in the national economy and may generate a misleading picture of the underlying economic base and potential of a given place. We operationalize our perspective in two ways using a unique classification of 45 U.S. industry value chains together with a new rural-urban county typology. First, we investigate the role rural economies play in integrated national systems of production by exploring the overall rural-urban distribution of the 45 U.S. industry value chains and their functional economic characteristics in rural versus urban areas. Second, we explore the extent to which rural areas are part of regional industry clusters by using a local indicator of spatial association (LISA) to search for geographically distinct multi-county regions of value chain employment. We apply this regional cluster analysis approach to one particular value chain: motor vehicles. Our results demonstrate that rural America plays an integral part in a great variety of U.S. value chains. Federal, state, or local development agencies must be careful not to view rural cluster strategy strictly as the development of groups of linked and related industries concentrated in specific rural places. There is an opportunity to identify and leverage the advantages of rural locations for businesses and industries in globally competitive and geographically extensive value chains. Clusters have been linked to the competitiveness of nations, and the rural contribution to nations' competitiveness remains obscured if industry clusters are defined narrowly in geographical terms.

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Introduction

The role of industry clusters in rural economies received renewed attention with the February 2004 release of a U.S. Economic Development Administration (EDA) funded study by Harvard Business School's Institute for Strategy and Competitiveness (Porter et al., 2004). The report, entitled *Competitiveness in Rural U.S. Regions: Learning and Research Agenda*, examines the rural incidence of groups of local, natural resource-dependent, and traded industries defined by Michael Porter's cluster mapping project (Porter, 2003). The study emphasizes traded sector competitiveness as the central issue facing rural economies and finds evidence of industry clusters in rural areas, particularly in those adjacent to metropolitan counties. Based on those results, the authors call for additional research on the determinants of rural economic performance—especially the relationship between rural-metropolitan linkages and rural economic growth—as well as a national debate on federal policy toward rural economic development. As befits its title, the Harvard report's primary actionable policy recommendation is for a series of conferences that would revisit federal rural policy and stimulate new research and initiatives (Porter et al., 2004, p. 4). EDA's recent interest in rural clusters is further reflected in its commissioning of research at the University of Minnesota on rural-based knowledge clusters (Munnich, Schrock, and Cook, 2002).

The literature on industry clusters and rural economies is growing steadily, especially if one includes consulting studies and planning documents (Barkley and Henry, 1997; Gibbs and Bernat, 1997; Henry, Barkley et al., 1997; Bernat, 1999; Kim, Barkley, and Henry, 2000; Rosenfeld et al., 2000; Rosenfeld, 2001, 2002; RTS, 2003).

Researchers have struggled with the seeming paradox that the cluster concept presents for rural development. If industry clusters are "geographic concentrations of interconnected companies and institutions in a particular field (Porter, 1998, p. 78)", with "concentration" implying elements of both scale and critical mass, one is hard pressed to find many examples in rural areas. After all, "rural" is sparsely populated by definition and therefore likely to lack either scale or critical mass in most every industry aside from those that are heavily agricultural or natural resource-based. Rosenfeld argues that cluster researchers overemphasize scale and that the usual secondary data sources, too limited by problematic SIC and NAICS industrial classification schemes and coarse geographic detail, often fail to capture small and unique rural specializations that operate very much like larger, conventionally understood clusters (Rosenfeld, 2001; RTS, 2003). He encourages greater use of primary data collection methods for research and planning related to clusters in rural communities. Yet, the 2004 Harvard Business School study *did* detect clusters in rural areas using secondary data, as did broadly similar efforts by Gibbs and Bernat (1997) and Feser, Sweeney, and Renski (2005). What is clear from those relatively comprehensive empirical applications is that the definition of the central concepts of *clusters* and *rural*, as well as the specific data sources used to operationalize those definitions, very much drive the results.

The cluster concept has two key dimensions. The *economic* dimension refers to interrelationships between businesses regardless of location and the *geographic* dimension refers to the spatial juxtaposition or concentration of linked and related businesses (Feser and Sweeney, 2000; Feser, Sweeney, and Renski, 2005). The conventional view combines the two dimensions by explicitly defining industry clusters narrowly as groups of interdependent industries and related supporting institutions co-located in identifiable regions, consistent with Porter's definition of regional clusters cited above. Such a circumscribed perspective has tangible utility in certain applications.

There is also considerable practical value to separating the two dimensions, both conceptually and analytically, especially for the purposes of rural economic development planning and policymaking. Even if several dozen rural-based regional clusters in the U.S. can be found, as the Harvard study demonstrated, the vast majority of rural places across the United States are not part of those clusters. Therefore, many of the compelling insights derived from applications of the industry cluster concept, particularly regarding the role of industrial interdependence as a key driver of business competitiveness, might be thought to have no relevance for most of rural America. Finding a few instances of clusters anchored in rural places in the U.S., however, does not exhaust the potential of industry cluster analysis to inform local and regional development strategy design and implementation.

The fullest understanding of the implications of business clustering for rural economies requires distinguishing between the economic and geographic dimensions of the concept by viewing clusters on a spatial continuum, from those that are national or even global in geographic scope to those that are highly localized in specific places. We operationalize this perspective in two ways. First, we investigate the role rural economies play in integrated national systems of production by exploring the overall rural-urban distribution of U.S. industry value chains and their functional economic characteristics in rural versus urban areas. A national industry value chain *i*, among a set of value chains *i* to *j*, is comprised of industries that are closely linked through their exchange of commodities and services. They are defined for the national economy as a whole and therefore are purposely aspatial. This approach enables us to identify the rural role in every value chain in the U.S. economy. Second, we explore the extent to which rural areas are part of *regional* industry clusters by using a local indicator of spatial association (LISA) to search for geographically distinct multi-county regions of high employment in a particular value chain. We apply this regional cluster analysis approach to one value chain: motor vehicles.

Our analysis is especially distinctive in two respects. First, we utilize a newly developed set of 45 national industry value chains as the basic industrial units of analysis. Second, we use a new urban-rural county typology that distinguishes counties by classifying them according to their internal urban-rural composition rather than their integration (or non-integration) with other counties. Under the typology, counties defined as *urban* have very little rural population (only up to 10 percent), while *rural* counties have very little urban population (Isserman, 2005). Two intermediate categories of counties—*mixed rural* and *mixed urban*—acknowledge the large number of U.S. counties that are to considerable degree both urban and rural. We are especially interested in the 1,790 counties that are strictly rural under our typology. Strictly rural counties, which consist of 1,486 nonmetropolitan counties and 304 metropolitan counties, have at least 90 percent of their populations in rural areas and/or no urban area of 10,000 or more. Because they are overwhelmingly rural in their spatial makeup and population, they present some of the most challenging cases for rural economic development.

In the next section, we discuss the general concept of economic interdependence and the specifics of the derivation of 45 national value chains. We follow with an explanation of the urban-rural county classification. We then present two sets of analyses. The first identifies the urban-rural distribution of employment in the 45 value chains and whether rural areas tend to specialize in selected segments of the value chains, such as lower wage industries. That analysis helps to reveal rural economies' functional role in national systems of production. The second analysis demonstrates how a local indicator of spatial association (LISA)—the local Moran's *I*—can be used to further explore the rural-urban geography of value chains. A LISA reveals the extent to which a given value chain is spatially concentrated in geographically distinct multi-county regions. As demonstrated by our study of the motor vehicles value chain, those regional clusters may vary considerably in the rural-urban composition and functional distribution of their value chain employment.

Capturing Economic Interdependence: National Value Chains

There are two basic perspectives from which one might view the role of industry clusters in rural economies. The first, and perhaps most conventional view, is that linked industries and related institutions co-located in a rural region are the most important potential sources of income and productivity growth for that region. Though the direction of causality between clustering and economic performance has yet to be definitively established, some studies have found that clusters are characterized by higher rates of productivity, innovation, and wage growth (Gibbs and Bernat, 1997; Porter, 2003; Porter et al., 2004). Those findings have naturally encouraged searches for spatial clusters that are wholly contained, or at least primarily anchored, in rural places. For example, Porter et al. (2004) find 25 examples of traded clusters centered in nonmetropolitan counties in the U.S., while RTS (2003) describes 22 domestic and five international cases of rural clusters, from aquaculture in coastal Maine to wireless communications in North Jutland, Denmark. The implication for rural development policy makers is that they should provide the business framework conditions, and perhaps selected investments and incentives, to support the growth of locally anchored clusters.

A second perspective views industry clusters on a spatial continuum, from those that are national or even global in scope to those that are highly localized, and views functional or economic interdependence as an important force underlying business and industrial competitiveness. Economic interdependence may or may not be associated with a pattern of geographic concentration. Indeed, as Porter (1990) originally emphasized in *The Competitive Advantage of Nations,* while internationally competitive clusters may have a tendency to co-locate, co-location is not a rule. From that perspective, rural economies may depend on—as well as contribute to—the competitive success of clusters anchored elsewhere. Put differently, the most important “cluster” for a given rural community’s economic future might be based in the rural locality itself, in a nearby urban area, or 1,000 miles away. A search for strictly locally-based clusters, or even those nearby that spill into rural communities, may generate a misleading picture of the underlying economic base and prospective economic potential of a given place.

We can explore the characteristics of rural economies from both perspectives if we maintain a conceptual and operational distinction between economic interdependence and geographic clustering. We do this by first defining a set of national industry value chains, or groups of industries related through the mutual exchange of commodities and services, and examining the unique geography of the chains in a second step. We call distinct spatial concentrations of the chains *geographic* or *regional clusters*. Note that regional scientists in the 1960s and 1970s referred to groups of linked industries as *clusters* and geographic concentrations of such clusters as *complexes* (Roepke, Adams et al., 1974; Czamanski, 1976; Latham, 1976; Czamanski, 1977; Latham, 1977; Czamanski and Ablas, 1979; Ó hUallacháin, 1984; Howe, 1991). Although there was clarity in that early literature that still eludes much of the modern work on industry clusters, we elect to drop the now infrequently used term *complex* but maintain the useful distinction between the economic and spatial dimensions of interdependence. The following describes the derivation of the national value chains. The methodology is similar in spirit to the approach in Feser and Bergman (2000), but the algorithm and application to the most recent benchmark input-output data are entirely new.

We may think of a given industry *i*'s value chain as industry *i* itself together with its supplier (upstream) and customer (downstream) industries. In principle, there is a distinct value chain for each industry. In practice, however, we are interested in identifying a reduced number of value chains that represent groups of industries with highly similar, and therefore linked, chains. Then, any given group would be comprised of industries whose linkages with one another are stronger than their linkages with industries outside the group. In any analysis of industrial linkages, there is a necessary trade-off between admitting detail in the specification of the linkages between industries and the practical need to narrow the focus to the strongest linkages in order to keep the scope of the application manageable.

Intuitively, what we would like to do is to compare the linkage patterns of each pair of industries in order to assess their degree of overlap. Depending on how we specify the parameters of that comparison, different types of value chains can be derived.

For example, linkage patterns along four dimensions—the similarity of the suppliers to industries *i* and *j*, the similarity of the buyers from industries *i* and *j*, the similarity in industry *i*'s suppliers to industry *j*'s buyers, and the similarity of industry *i*'s buyers to industry *j*'s suppliers—could be compared by calculating four pairwise correlations on industry purchasing and sales vectors derived directly from an input-output transactions matrix. The maximum correlation among the four, the indicator of the strength of linkage between each pair of industries, could then be used to form a similarity matrix for analysis with conventional data reduction techniques such as factor analysis or statistical cluster analysis. Indeed, that approach was laid out by Czamanski (1974) and adopted more recently by Feser and Bergman (2000) to develop of a set of national manufacturing value chains using U.S. 1987 input-output data.

A problem with using correlations calculated directly from purchases and flows data is that they can be skewed by very large flows between comparatively few industries. The volume of purchases of industry *i* from industry *j* is sometimes, but not always, the best indicator of the importance of industry *j* to *i*, for example. Because *i* and *j* both make relatively large purchases from the same comparatively small set of producer services industries, as most industries do, does not mean *i* and *j* are necessarily closely linked. Yet a correlation between the two industries' supply vectors would be very high. In general, the correlation approach has difficulty identifying distinct value chains, a problem that led Feser and Bergman (2000) to restrict their analysis to the manufacturing industry, thereby eliminating the tendency of purchases from general purpose producer services industries to "pull" otherwise unrelated industries into large, nebulous value chains.

A solution to the problem is to begin by defining sets, S_i and B_i, where S_i is the set of supplier industries to industry i and B_i is the set of purchasing industries (buyers) from industry i.[1] At the extreme, S and B would contain, for industry i, all industries j for which x_{ij} and y_{ij} are, respectively, greater than zero. In practice, we may set a threshold, α, that x_{ij} and y_{ij} must exceed in order for industry j (i) to be included in industry i's (j's) set of key suppliers (or buyers). Given S and B, we can define:

$$\begin{aligned} I_{ij}^{SS} &= S_i \cap S_j, \quad U_{ij}^{SS} = S_i \cup S_j \\ I_{ij}^{BB} &= B_i \cap B_j, \quad U_{ij}^{BB} = B_i \cup B_j \\ I_{ij}^{SB} &= S_i \cap B_j, \quad U_{ij}^{SB} = S_i \cup B_j \\ I_{ij}^{BS} &= B_i \cap S_j, \quad U_{ij}^{BS} = B_i \cup S_j \end{aligned} \tag{1}$$

From (1) we can construct the following four measures:

$$R_{ij}^{SS} = \frac{I_{ij}^{SS}}{U_{ij}^{SS}}, \quad R_{ij}^{BB} = \frac{I_{ij}^{BB}}{U_{ij}^{BB}}, \quad R_{ij}^{SB} = \frac{I_{ij}^{SB}}{U_{ij}^{SB}}, \quad R_{ij}^{BS} = \frac{I_{ij}^{BS}}{U_{ij}^{BS}} \tag{2}$$

The ratios in (2) measure the proportion of shared linkages between industries i and j along four dimensions. For example, R^{SS} is the number of supplier industries that industries i and j have in common over the total number (or universe) of supplier industries to i and j. The higher is R^{SS}, the stronger is the value chain linkage between i and j as indicated by joint sourcing from the same suppliers. Similarly, R^{BB} is the share of common buyer industries. R^{SB} and R^{BS} are measures of second-tier relationships between each pair of industries; they increase as one industry's suppliers are another's buyers. The shares in (2) eliminate the volume of dollar flows as an indicator of the importance of a given pairwise linkage. Each linkage as represented by the simple presence of a purchasing or sales flow is treated equally.[2] Even more importantly, we can weight certain pairwise linkages more than others. Acknowledging the problem with producer services noted above when deriving the value chains, we designated industries such as wholesale trade, information, legal services, advertising, finance, and insurance as *enabling* industries and assigned a weight (<1.0) that reduced their influence in the calculation of the *R* measures. Thus distinct or unique linkages between industries were weighted more than the joint consumption of broadly similar mixes of producer services, without excluding linkages with producer services entirely as in Feser and Bergman (2000). Other weighting schemes could be used depending on the question at hand. For example, we might weight technology-intensive industries more than others as a means of emphasizing technology-based linkages. Note that each indicator in (2) may be interpreted as a simple share of common linkages and is therefore a simple and intuitive measure of the strength of the tie between any two industries.

Figure 1 summarizes steps in the development of the chains with 1997 benchmark U.S. input-output data.[3] The process begins by eliminating 26 primarily local serving and government enterprise industries, reducing the 489 sector inter-industry transactions matrix to a 463 dimension matrix. A weight of one-third, or 0.33, was then applied to each of 55 general enabling producer services industries prior to the calculation of the *R* measures. While the weight is admittedly arbitrary, groupings generated by statistical cluster analysis with weights of 0.75, 0.5, 0.33 and 0.25 were compared to determine the thresholds at which enabling linkages began to dominate adversely the identification of the value chains. The notion was to select the maximum weight that still yielded distinct chains. The level 0.33 met that criterion.[4]

The next step is to check the number of total linkages per sector. The great majority of industries post at least 20 linkages with other industries. However, 32 of 463 industries post very few or no interindustry linkages. Those 32 industries' predominant intermediate transactions are either with themselves or with the 26 local serving industries eliminated from the reduced transactions matrix in an earlier step. Such "singleton" industries (or "isolates" in a network analysis context) were dropped temporarily at this stage, reducing the linkage matrix to 431 industries. The singletons were reintroduced into the analysis in subsequent steps, as described below. Selecting the maximum of the four *R* measures produced a 431-dimension linkage matrix ($\mathbf{R}^{\mathbf{MAX}}$) that was then analyzed using Ward's hierarchical clustering algorithm.

Initial inspection of the Ward's clustering results indicated a solution of between 40 and 50 distinct value chains. To add an additional measure of sensitivity testing, all chain splits for solutions between 30 and 60 clusters were examined to identify the solution that met both statistical and interpretability criteria. That solution proved to be 43 distinct clusters or value chains.[5] At this stage, five of the singleton industries were reintroduced into the analysis. An inspection of purchase and sales flows for each singleton industry made clear that input-output (IO) sectors 312120 (breweries) and 312140 (distilleries) form the core of a small breweries and distilleries chain, while IO sectors 316100 (leather and hide tanning and finishing), 316200 (footwear manufacturing), and 316900 (other leather product manufacturing) form a leather products chain. The breweries and leather products chains were therefore added to the set of 43 derived from statistical cluster analysis to produce a total of 45 value chains.

Industry membership in the 45 chains is exclusive at this stage; industries are members of only a single chain. The final step is to acknowledge the inherent "fuzziness" among inter-industry linkages, namely that every industry is linked at some level to every other industry, with the strength of that linkage ranging from 0 (no joint buyers or suppliers) to 1 (identical buyer and supplier linkages). Taken together, the industries that make up any one of the initial, mutually-exclusive 45 clusters are simply more strongly related to each other than to any other identified groups. Any particular industry may also have reasonably tight linkages with other value chains. That fact is acknowledged by viewing the results of the Ward's cluster analysis as defining a set of *core* value chains, each made up of *primary* sectors. A non-primary industry, *s*, is defined as a *secondary* industry to a given value chain if its average linkage with primary industries of that chain exceeds some threshold, δ. Progressively lower levels of δ increases the "fuzziness" among value chains. Setting $\delta = 0$ effectively includes all industries in all value chains (maximum fuzziness).

Selecting the appropriate level of δ was resolved by inspecting the distribution of average linkages with the use of *z* scores. An average linkage for each industry *i* across *n* primary industries *j* in cluster *k* was calculated as:

$$\overline{r}_{ik} = \frac{\sum_{j=1}^{n} r_{ijk}^{MAX}}{n} \qquad (3)$$

The measure $\overline{r}_{ik}$ is the arithmetic mean of the maximum linkages between industry *i* and the primary industries in core cluster *k*. Including all singleton industries, the values $\overline{r}_{ik}$ can be arrayed in a 463 row by 45 column matrix and converted to *z* scores in the usual fashion:

$$z_{ik} = \frac{\overline{r}_{ik} - mean(\overline{r}_{ik})}{s.d.(\overline{r}_{ik})} \qquad (4)$$

Each industry i was then defined as a secondary industry in cluster k where $z_{ik} > 2.25$. Note that singleton industries, along with other industries, are assigned as secondary industries to the core chains for which they post the strongest average linkage. Thus some singleton industries are not primary industries in any of the 45 value chains.

Table 1 provides an example of the value chain analysis results.[6] It reports the detailed sectoral makeup of the national motor vehicles value chain cluster, including each member industry's average linkage indicator and z score. The higher the linkage factor for industry i, the more closely i is tied to the overall chain (i.e., the more closely i's own unique value chain aligns with the value chains of other cluster members). While primary industries are those that are most closely linked within the chain, they are not necessarily end market industries. Note that the motor vehicles value chain is comprised mostly of industries in NAICS 336, transportation equipment manufacturing. However, it also includes one industry from NAICS 334, computer and electronic product manufacturing, and 335, electrical equipment, appliance and component manufacturing. Six members are primary and six are secondary. Three of the industries in the chain—all other transportation equipment manufacturing, boat building, and electric lamp bulb and part manufacturing—are singleton industries that have comparatively few interindustry linkages overall (indicated by a 0 in the "Primary ID" column); based on the limited linkages they do have, they are most closely related to motor vehicles. The primary members of the motor vehicles chain are mostly end market industries (trucks, cars, mobile homes, and campers).

The full list of 45 value chain clusters is provided in Table 2. The descriptor for each cluster represents the predominant economic activity among the group of industries, particularly those that are most tightly linked within the cluster. The descriptors should be interpreted carefully and not too literally. No descriptor can adequately capture all of the relationships among industries in each value chain. Together, the industries included in the value chains constitute a significant fraction of U.S. economic activity, roughly 65 percent of total U.S. employment in 2004, and somewhat more if measured by payroll or output.[7] Industries not included in the clusters, as noted above, are retail trade, government (including the U.S. Postal Service), primary and secondary schools, and consumer and personal services. Note that the value chains are not industries in the conventionally defined sense. For example, the 49 six-digit NAICS industries in the textiles and apparel value chain are drawn from 3 two-digit NAICS codes, 6 three-digit NAICS codes, 12 four-digit NAICS codes, and 22 five-digit NAICS codes.

Defining Rural and Rural Economic Specialization

Given the chains, we can explore rural economies' role as production locations in national systems of linked and related industries. However, investigating the spatial characteristics of the 45 value chains, and particularly their rural-urban distribution, requires appropriate definitions of *rural* and *urban*. When researchers study the rural economy, they almost always use county data and treat non-metropolitan as synonymous with rural. The federal government does it, the Federal Reserve Bank does it, and seasoned, excellent scholars do it, but it is wrong. The majority of rural people and more than a million farmers live in metropolitan counties. This section outlines a better approach, explaining why it is necessary and how it builds on the existing federal data system. The key notion to appreciate is how urban-rural integration, which the Office of Management and Business seeks to capture in defining metropolitan and micropolitan core-based regions, differs from urban-rural character, which the Census Bureau seeks to capture when it defines urban and rural areas.

The Census Bureau system distinguishes between urban and rural, building up urban areas a few census blocks at a time starting with cores that have 1,000 or more people per square mile and adding adjacent block groups with 500 or more density and some other block groups that meet specified requirements. The algorithm, explained in various issues of the Federal Register, is distilled into ten steps in Isserman (2005), which discusses in more detail the ideas presented in this section. Conceptually, the Census system identifies built up areas, thereby approximating the separation of the landscape into urban and rural, town and country, as one would see it if viewed from the air. If the population of the qualifying combination of block groups reaches 2,500 it qualifies as an urban area. In official Census terminology, urban areas with more than 50,000 people are called urbanized areas, and those with 2,500 to 49,999 people are called urban clusters. Any space not assigned to urban areas is defined as rural. The nation's rural areas occupy 97.3 percent of the land and house 20 percent of the population, or 55 million people. In contrast, the 38 urbanized areas with one million or more people house 42 percent of the population on 1.0 percent of the land at a population density of 3,400 people per square mile. In all, 70 percent of the nation's population lives in urbanized areas, and 11 percent in urban clusters.

We know very little about the economies of urbanized areas or rural areas because we do not have comprehensive economic data for them as we do for counties. Counties provide poor substitutes for urban and rural data, however, because only one in four counties is entirely rural or urban. There are 43 counties with no rural population, but only 7 percent of the urban population, 8 percent of the urbanized area population, and less than 6 percent of the nation lives in these purely urban counties. Likewise, there are 733 counties with no urban population, but only 10 percent of the rural population and 2 percent of the national population live in these purely rural counties. Most people live in counties that combine urban and rural areas: 90 percent of rural residents, 93 percent of urban residents, 92 percent of urbanized area residents, and 99.9 percent of urban cluster residents.

Well aware of the fact that most counties combine urban and rural areas, the Office of Management and Budget takes counties as building blocks and sorts them into core-based regions, including metropolitan statistical areas. The goal is to describe functionally integrated regions that have a densely settled nucleus. An urbanized area is the required population nucleus for a metropolitan area, and its entire county or counties become the core of the metropolitan area. Adjacent counties, including purely rural ones, are added to the metropolitan area if 25 percent of their employed residents work in the core counties (or in rarer cases, if 25 percent of the core counties' employed residents work in the adjacent county). The same process defines micropolitan counties but the required core is an urban cluster of 10,000 or more. Thus, an urban area of 50,000 or more seeds a metropolitan area, and a smaller one seeds a micropolitan area. All counties not in a metropolitan or micropolitan area are officially designated as "Outside Core Based Statistical Regions."

The federal government has defined metropolitan areas since 1950, always using the concept of integrated functional areas that combine urban and rural areas. Recognizing integrated regions centered on smaller urban areas is new, micropolitan areas having been designated for the first time in 2003. Also new is the reliance on commuting as the sole criterion for adding surrounding counties. Previously "metropolitan character" also mattered, and it was defined in terms of density and urban population with various sliding scales and tradeoffs among the three measures. For example, if 50 percent of a county's employed residents commuted to the metropolitan area, the county was added if it had a population density of 25 people per square mile or 10 percent of its population lived in urban areas; if 25 to 40 percent commuted, the county could qualify by meeting two of three other criteria, such as a density of 35 people per square mile, 35 percent urban population, or 5,000 people in an urban area. Removing all but the commuting requirement made more likely the inclusion of counties of rural character into metropolitan areas. In fact, there are 95 purely rural counties in metropolitan areas.

There was never any intent, explicit or implicit, to make metropolitan synonymous with urban and nonmetropolitan synonymous with rural, but that is the widespread practice in academic and government research. The reason the practice should be abandoned is evident in Table 3, which shows counties organized by Beale codes, a popular taxonomy developed by the U.S. Department of Agriculture. The Beale code system's first three categories are counties in metropolitan areas. Those metropolitan counties together house 51.1 percent of the national rural population in 2000, hence, the statement that the majority of rural people live in metropolitan areas. Likewise, over 40 percent of the farm population lives in metropolitan counties. Hence, it makes little sense to continue treating nonmetropolitan counties as proxies for rural America. Most categories of the Beale code have a mix of urban and rural residents. The rural proportion ranges from 7 percent to 30 percent of the populations of the three metropolitan categories and from 36 percent to 66 percent of the populations of the first four nonmetropolitan categories. Thus, even the nonmetropolitan counties are mixed and have substantial urban population shares. Only the last two categories of the Beale system come close to representing purely rural counties, but together they house only 9 percent of the rural population and 13 percent of the farm population.

The categories we use focus on the urban and rural character of counties, not economic integration, the crux of the metropolitan and core based system. The rationale is described more fully in Isserman (2005). The four categories and the criteria are:

- Rural county: (1) the county's population density is less than 500 people per square mile, and (2) 90 percent of the county population is in rural areas and/or the county has no urban area with a population of 10,000 or more. The density requirement is the same used by the Census Bureau to distinguish urban and rural census blocks, and the urban area threshold follows the urban cluster requirement used by OMB to define micropolitan core areas. The 90 percent requirement, which screens out low-density counties with substantial urban populations, has no official precedent or standing.
- Urban county: (1) the county's population density is at least 500 people per square mile, (2) 90 percent of the county population lives in urban areas, and (3) its population in urbanized areas is at least 50,000 or 90 percent of the county population. The density and the 90 percent requirement serve as above, and 50,000 is the OMB urbanized area threshold for the nucleus of a metropolitan county. The third criterion has two parts because of independent Virginia cities;

treated as counties statistically by the Census Bureau, some have fewer than 50,000 residents but are entirely or almost entirely within larger urbanized areas that spill over their borders.

- Mixed rural county: (1) the county meets neither the urban nor the rural county criteria, and (2) its population density is less than 320 people per square mile. That density is two acres per person; it has no official standing but seems reasonable.
- Mixed urban county: (1) the county meets neither the urban nor the rural county criteria, and (2) its population density is at least 320 people per square mile. Thus, mixed urban counties are almost two-thirds of the way to the urban density threshold of 500 people per square mile.

Defined this way, rural and mixed rural counties house 85 percent of the rural population and 91 percent of the farm population (see Table 4). Therefore, studying these two categories recognizes considerably more rural people than the nonmetropolitan designation. Inclusion of the mixed urban counties accounts for 95 percent of the rural population. With each step from rural to urban, the rural population is a smaller proportion: 76 percent of rural counties, 33 percent of mixed rural, 15 percent of mixed urban, and 2 percent of urban. The four categories are a continuum, dubbed the rural-urban density code in Isserman (2005). Figure 2 maps the county types.

This system for identifying the urban-rural character of counties can be combined with any of the systems that identify integration and adjacency. For example, rural metropolitan and rural nonmetropolitan are two categories of such a combined system. Table 5 shows that 9 percent of the rural population is in rural metropolitan counties, 27 percent in mixed rural metro counties, 10 percent in mixed urban metro counties, and 5 percent in urban metro counties, thus accounting for the entire rural majority found in metropolitan areas.

There are meaningful differences in the economies of rural, mixed rural, mixed urban and urban counties. Table 6 reports the percentage of national employment in each two-digit NAICS industry in each of the four county types along with corresponding location quotients.[8] Rural counties have 6 percent of total private nonfarm employment and 10 percent of manufacturing employment. All location quotients greater than one indicate relative specialization; rural counties have almost twice the share of manufacturing employment (LQ=1.8) as they do total employment. Rural counties are relatively specialized in seven two-digit industries: forestry, fishing, hunting, and agriculture support, mining, utilities, manufacturing, retail trade, health care and social assistance, and accommodation and food services. Mixed rural counties specialize in those industries and construction as well. Urban counties specialize in a very different set of industries, among them, information, finance and insurance, professional and scientific/technical services, management of companies and enterprises, real estate and rental and leasing, and educational services,. Mixed urban counties show the least specialization, with no location quotient exceeding 1.1 or 10 percent above the national share.

Another cut of these numbers is helpful in understanding the importance of each industry to rural economies. It demonstrates again that the new definitions of county types appear to be useful in identifying unique economic characteristics of rural places. Table 7 reports the percent of all jobs each industry provides in each county type. The four largest private nonfarm employers in rural counties are manufacturing, retail trade, healthcare and social assistance, and accommodation and food services. Together those industries account for almost two thirds of the private nonfarm jobs in rural economies. The number falls monotonically across the four county categories, from 64 percent of rural jobs to 42 percent of urban jobs. The biggest single difference is for manufacturing, which accounts for 23 percent of rural jobs and only 8 percent of urban jobs.

Identifying the Rural Role in National Value Chains

Our industrial and rural-urban classifications enable us to identify the distribution of the 45 U.S. value chains among urban and rural areas of the country and, thereby, to demonstrate how rural economies fit into the national system of production.[9] Knowing the rural role will help policy makers and others interested in rural development both understand how rural areas contribute to the competitiveness of national value chains and anticipate how changes in the fortunes of particular value chains will affect rural areas. For example, knowing the role of rural areas in the national motor vehicle supply chain is fundamental to understanding the rural implications of the current downsizing of General Motors and Ford.

The employment shares of rural, mixed rural, mixed urban, and urban counties vary considerably among the 45 value chains. As expected, the chains with the strongest rural presence are natural resource based; while only 5.8 percent of total U.S. private nonfarm employment is in rural counties, the mining, wood processing, and feed products chains have 23 to 36 percent of their jobs in rural counties (see Table 8). Of the 20 value chains with rural county shares greater than 10 percent, most are natural resource based, including grain milling, wood building products, concrete and brick building products, petroleum and gas, and several durable and nondurable manufacturing chains, among them wood products and furniture, chemical-based products, packaged food products, leather products, textiles and apparel, nondurable machinery, and motor vehicles. At the other extreme, 12 chains—mostly either technology intensive or focused on advanced producer services—have less than five percent of their employment in rural counties (e.g., aerospace, financial services and insurance, information services, computer and electronic equipment, printing and publishing, business services, and arts and media).

Combining rural and mixed rural counties, where together 85 percent of rural people live, captures over 50 percent of the employment of 13 of the 45 U.S. value chains. All but one, appliances, are agricultural or other natural resource based. There are an additional 15 chains with at least 40 percent of their employment in rural and mixed rural counties. Manufacturing-oriented chains dominate those, including, among others, motor vehicles (49 percent of total chain employment in rural areas), construction machinery and distribution equipment (49 percent), rubber products (48 percent), plastics products (47 percent), nondurable industry machinery (46 percent), and machine tools (40 percent). In short, rural workers contribute to and are dependent on a considerable range of the nation's value chains.

Having documented the important overall rural role, the next interesting question is whether rural areas specialize in selected segments of various value chains, particularly industries less central to the chains or lower wage industries. We explore these two issues in turn. First, we check the urban-rural distribution of value chain employment in the *primary* industries, defined as those most tightly linked together within given value chains. In any value chain i, the degree of economic interdependence among primary industries is significantly greater than the interdependence among secondary industries or the degree of interdependence between primary and secondary industries. Recall from the value chain clustering methodology that *secondary* industries in value chain *i* are, by definition, more tightly linked to another value chain *j* (Feser and Bergman, 2000). While primary industries may be thought of as the core of a given chain, they are not necessarily higher productivity, higher value-added, higher wage, or end market industries. For example, wood household furniture (NAICS 337122), a consumer end market industry, is a primary industry in the wood products and furniture value chain but a secondary industry in the wood processing value chain. If only the secondary components of various chains are located in rural counties (i.e., they do not anchor the core of any value chain), that would suggest that rural areas only play a peripheral role in the U.S. economy across the industrial base.

Table 9 shows that rural counties account for more than 6 percent of the U.S. primary industry employment in 27 of the 44 chains for which primary and secondary industry activity can be distinguished reliably. Again, that is significant given that just 5.8 percent of private nonfarm employment overall is found in rural counties in 2002. Several of those 27 chains are moderately to highly technology-intensive, including precision instruments, nondurable industry machinery, construction machinery and distribution equipment manufacturing, motor vehicles, plastics products, and appliances. Comparing overall and primary industry rural share gives a picture of the relative rural role; rural counties have key roles at the defining core of some value chains and more generic roles in others. For the wood processing chain, for example, rural counties capture 36.8 percent of employment in primary industries compared to 24.3 percent of overall employment. On the other hand, rural counties are home to 11.1 percent of motor vehicles chain *overall* employment but only 8.5 percent of motor vehicles primary industry employment. Such differences show the importance of both kinds of analyses in understanding the rural role in the U.S. economy. Together, rural and mixed rural counties account for over 50 percent of primary industry activity in 13 of 27 chains, most of which are natural-resource based or closely linked to natural resources or agricultural, among them packaged food products, chemical-based products, construction machinery and distribution equipment manufacturing, wood building products, and rubber products.

Next we examine the urban-rural distribution of higher wage employment in each chain, where "higher" wage industries in U.S. value chain *i* are defined as those at or above the median U.S. wage for all industries in value chain *i*. Table 10 reports the share of each county type's value chain employment that is found in higher wage industries. There is clearly a greater tendency for rural counties to specialize in the lower wage components of various value chains compared to mixed rural, mixed urban, and urban counties. The number of chains for which higher wage employment is 50 percent or greater of overall chain employment is 13 for rural counties, 23 for mixed rural, 24 for mixed urban, and 29 for urban.

The rural value chain activity we are observing—particularly in manufacturing or producer services-based chains—may be concentrated predominantly in rural counties that are located in metropolitan areas rather than in rural places more remote from urban centers. If that were true, rural employment in various chains, which are by definition comprised of non-local serving industries (i.e., export oriented industries), might be interpreted as simply spillover growth from urban centers. Table 11 investigates this question by reporting the shares of total rural and mixed rural value chain employment in rural and mixed rural counties located outside of metropolitan areas. Even though most rural counties are non-metro, it is possible that the distribution of rural value chain employment is skewed toward those comparatively fewer rural counties in metro areas. In fact, non-metro rural counties account for a significant majority of total rural employment in every chain. The chains for which the non-metro rural counties employment shares are lowest—though still above 70 percent—tend to be technology-oriented or higher end business services, including pharmaceuticals, optical equipment and instruments, and aerospace. Mixed rural counties are more commonly located in metro areas: the share of mixed rural employment in non-metro mixed rural counties peaks at 46.6 percent for the mining chain and is lowest for construction (24.7 percent), financial services and insurance (23.8 percent), computer and electronic equipment (20.5), and aerospace (16.4 percent).

In summary, rural and mixed rural counties have significant roles in numerous, diverse value chains. This statement holds true whether one focuses on the primary, distinguishing core industries of a value chain or its higher wage industries. It also holds true for rural and mixed rural counties whether they are within metropolitan areas or father away from such integrated regional economies. Rural and mixed rural counties do not always play a secondary role in key U.S. value chains, nor are they always the location of lower wage segments in key chains. Thus, understanding and supporting the competitiveness of U.S. industry entails recognizing and supporting its rural-based component.

Identifying the Rural Role in Regional Clusters: Motor Vehicles

For many if not all of the value chains, some share of national economic activity will be clustered in distinct multi-county regions, while the remainder will be scattered among individual counties. The identifiable regional concentrations may consist of wholly urban counties or some combination of urban, mixed urban, mixed rural, and rural counties. Alternatively, the concentrations might be comprised of mostly rural or mixed rural counties. Furthermore, certain types of counties might play identifiable functional economic roles within distinct geographic clusters, such as specializing in primary industries or lower wage segments of given value chains.

In this section we investigate the rural-urban distribution and functional characteristics of discrete geographic concentrations of given value chains. Since analyzing the regional spatial characteristics of all 45 chains would take us beyond the scope of a single paper, we demonstrate our approach with an application to one value chain: motor vehicles. The motor vehicles value chain has been particularly important for the economic fortunes of rural communities both in the newly developing Southern automotive corridor and the traditional automotive industrial heartland of the upper Midwest. Ongoing restructuring in the industry, evidenced most starkly in the November 2005 announcement of General Motors to cut its U.S. workforce by some 30,000, underscores the importance of understanding the regional economic implications of the industry. Indeed, there is already a growing literature on shifts in agglomeration and regional clustering in the U.S. motor vehicles industry (Rubenstein, 1992; Smith and Florida, 1994; Klier, 1998; Klier, 2000; Weiler, Thompson, and Ozawa, 2001; Klier, Ma, and McMillen, 2004; Klier, 2005).

We can detect multi-county concentrations of value chain activity by applying a local indicator of spatial association (LISA) to county-level value chain employment or establishment data (Anselin, 1995). While several roughly comparable LISAs are available, we elect to use the local Moran's *I*, a common indicator included in several off-the-shelf software packages. The local Moran's *I* searches for "hot spots" in geographic space, or groups of proximate counties with high or low values on a given indicator. For example, Figures 3 and 4 map county-level employment location quotients for the motor vehicles manufacturing industry (NAICS 3361) and the broader motor vehicles value chain, respectively. Both maps indicate a high degree of clustering, i.e. the existence of distinct regions comprised of counties with a relative specialization in motor vehicle production. The Moran's *I* indicates areas where the level of employment clustering significantly exceeds what would be observed if value chain employment was scattered randomly over space.

We carried out our calculations on 2002 county-level motor vehicles value chain employment in GeoDa software utilizing a first-order, rook spatial weights matrix with pseudo significance levels based on 9,999 simulations. We classify a county as part of a geographic cluster if its pseudo significance level is less than or equal to 0.05. We identify only high-high cluster counties, since that indicates positive spatial autocorrelation as well as a relatively high number of motor vehicles value chain jobs. Discrete geographic clusters then consist of an identifiable concentration of all high-high counties and their adjacent county neighbors. Adjacent neighbors are included because they are likely to have high value chain employment (since high-high counties have high neighbors) but are not classified as high-high by the Moran's *I* because of low value chain employment in their own adjacent neighbors. This border problem is common to all LISAs.

Using this procedure, we identified 360 counties where multi-county clustering of the motor vehicles value chain is evident. Those 360 counties are shown in Figure 5, which distinguishes high-high and adjacent counties. Next, from among the 360 counties we identified the fifteen distinct geographic clusters of motor vehicles chain activity displayed in Figure 6. In most cases, individual spatial clusters were easy to delineate due to their clear geographical separation from other clusters. The principle challenge was detecting distinct geographic clusters in the upper Midwest. That the U.S. motor vehicles industry remains very heavily concentrated in Michigan and its surrounding states, extending over many counties, is clearly illustrated in Figures 3 and Figure 7, where the latter shows total vehicle units produced by vehicle assemblers. However, we were able to distinguish Kentucky and Chicago-based clusters from the extended Detroit cluster. There were at least two adjacent counties between any Kentucky or Chicago high-high counties and a Detroit high-high county. We also distinguished a cluster near Buffalo where a single non-high-high county separated the Buffalo and Detroit groupings. Identifying discrete geographic clusters is not an exact science, but the separation among the fifteen geographic motor vehicles clusters appears to be fairly robust and intuitive.

The fifteen clusters, each with a name that refers to the general region in which they are located, are listed in Table 12 along with their composition by county type. Twelve of the 15 spatial clusters include rural counties. Two clusters—one in the Carolinas and one near Knoxville—include no urban counties. The largest cluster in terms of both employment and spatial extent is the one centered on Detroit. It consists of 163 total counties, including 40 rural and 90 mixed rural. Next largest is the Kentucky cluster, in which 31 of 36 counties are rural or mixed rural. The eight Southeastern clusters (Kentucky, St. Louis, Nashville, Dallas, Kansas City, Carolina, Knoxville, and Atlanta) together have 44 rural counties out of 122 total counties, or 36 percent. In contrast, the other seven clusters have 50 rural countries out of 128 counties, or 21 percent. Thus, the automotive industry's vaunted "Southern strategy" is also very much a rural one.

Taking the 15 geographic clusters as a group, 4.8 percent of establishments and 4.7 percent of employment are situated in rural counties in 2002 (Table 13). Mixed rural and rural counties together account for 31.8 and 37.6 percent of motor vehicles chain establishments and employment, respectively. Those counties are less likely to capture the chain's primary industry—as noted above, primary industries are essentially auto and truck assemblers (see also Table 1)—or higher wage employment. Across the 15 clusters, urban and mixed urban counties capture 72.1 percent of primary industry employment and 63.1 percent of higher wage industry employment. Urban counties, in particular, capture more motor vehicles value chain activity than any other county type: 49.5 percent of establishments and 41.1 percent of employment.

Examining the regional clusters separately reveals significant differences in the spatial structure of the Detroit cluster versus newer clusters in the South, e.g., Nashville, Kentucky, and the Carolinas (See Tables 14a-14c). For example, in the Detroit cluster, rural counties account for 7.6 percent of establishments and 5.0 percent of employment. Those numbers would be reversed and the gap between them wider if rural counties in the Detroit cluster served mainly as locations for larger, greenfield-seeking plants. Indeed, the shares of establishments and employees are quite similar for all county types in the 163 county Detroit cluster. In contrast, in the Carolinas, Kentucky, Knoxville, and Nashville, mixed rural counties in particular have captured a substantially larger share of employment than establishments. In the 36 county cluster centered on Kentucky, rural and mixed rural counties account for 58.9 percent of employment but 50.0 percent of establishments; hence, the establishments are relatively large. The corresponding numbers for Detroit are 38.2 and 38.3 percent. There are similar contrasts for primary industries and higher wage industries.[10]

Driving the trends in motor vehicles cluster spatial structure in the Southeast are cost minimization strategies on the part of foreign assemblers (e.g., Nissan in Tennessee and Mississippi, Toyota in Kentucky, BMW in South Carolina, and Mercedes in Alabama). Foreign makers have consistently sought more peripheral greenfield sites suitable for vertically disintegrated, networked models of production (Weiler, Thompson, and Ozawa, 2001). The latter require suppliers to locate within a day's drive of the main vehicle assembly plant (Klier, 2005), not necessarily in the immediate vicinity. Thus, Southeastern assembly plants located in rural or mixed rural counties can create growth spillovers to nearby mixed urban and urban counties to the extent that some suppliers prefer more urbanized locations. The growth dynamic in the vehicle cluster in the upper Midwest is the opposite because the large assemblers are situated in urban and mixed urban counties.

Summary and Conclusion

We began this paper by claiming that maintaining a conceptual and operational distinction between the economic and geographic dimensions of the industry cluster concept would be a useful way to explore the role of industry clusters in rural economies. The economic space of a cluster refers to the functional interdependence among businesses and industries that make up the cluster, regardless of those businesses' and industries' locations. The economic cluster defined by functional interdependence is the national value chain (or even a global one). The geographic space of a cluster refers to the spatial configuration of interdependent businesses and industries. Most existing research combines the two dimensions into a single definition of regional clusters, implying that industry cluster analysis as applied to rural economies constitutes a search for industrial specializations anchored in rural places.

Although useful in some instances, the conventional approach is overly narrow for understanding rural development. It ignores significant interregional growth dynamics—particularly the potential for urban to rural spillovers, and vice versa—as well as other external linkages that exert a substantial influence on the prosperity of rural places. The economic fortunes of communities, whether urban or rural, are often driven by industries anchored elsewhere. The most important economic clusters for any given rural place can be local, regional, national, or even global in geographic scope.

In this paper, we have analyzed the rural characteristics of national value chains at two spatial scales: first, for the U.S. as a whole, breaking out rural, mixed rural, mixed urban, and urban counties; and, second, for motor vehicles, breaking out those county types in 15 sub-national regions where the value chain is concentrated. We found some expected things as well as some surprises. Based on 2002 employment data, rural and mixed rural counties capture over 50 percent of the employment of 13 of the 45 national value chains. As expected, most are agriculture or otherwise natural resource-based. Moreover, an additional 15 value chains have at least 40 percent of their employment in rural and mixed rural counties including, among others, motor vehicles, construction machinery, rubber products, plastics products and machine tools. We found that rural counties do not always specialize in secondary (weakly linked or peripheral) industries of given value chains, though the chains for which they have relatively more primary industry employment are often natural resource-based or closely linked to agriculture. We also found that while rural counties are specialized in lower wage segments of value chains more frequently than other county types, there many chains for which employment in rural counties is roughly evenly distributed between lower and higher wage industries, including knowledge-intensive chains like aerospace, financial services and insurance, pharmaceuticals, information services, and business services. Overall, the results paint a rich picture of rural places, one that highlights the diversity of rural economies as well as their integration with national systems of manufacturing and non-manufacturing industries. Far from the stereotypical image of the rural economy as consisting of farms, ranches, mines, forests, and the occasional manufacturing branch plant, rural America is an integral part of a wide range of national industries.

Our analysis of the geography of the motor vehicles value chain found that spatial motor vehicles clusters extend only modestly into the most rural counties, even with the growth of the industry in the Southeast. Geographic clusters of the motor vehicles chain in the Southeast tend to be substantially more rural in their makeup than the traditional concentration of activity centered on Detroit. Overall, however, newer sub-national motor vehicles clusters are often oriented toward mixed rural and mixed urban counties, perhaps reflecting the preference of foreign assemblers and their suppliers for lower cost greenfield sites that still enjoy ready access to urban areas and labor markets. Rural counties within geographic motor vehicles clusters are least likely to capture primary industry activity in the chain.

Combining the results of our two analyses of the motor vehicle value chain strongly supports our claim that the distinction between the economic and geographic dimensions is useful. Rural counties have 11.1 percent of total employment in the national value chain (Table 8) but only 4.7 percent of total employment in those parts of the national value chain found within the 15 geographical clusters (Table 13). Even more strikingly, rural counties have 23.5 percent of the value chain employment in primary industries nationally (Table 8), but only 1.6 percent in primary industries within the geographic clusters (Table 13. Extension of the data-intensive spatial clustering analysis to the remaining 44 national value chains is necessary to determine whether the rural-urban patterns detected in the analysis of the motor vehicles chain hold more generally, but there is no reason to suspect that the motor vehicle chain is unique in exhibiting major differences between its economic and geographical clusters. Not all activities within a value chain co-locate.

The rural development implications of our findings are important. First, regional clusters of interrelated industries have both urban and rural components. Looking for geographical clusters only within rural areas overlooks much, if not most, of the rural role in national value chains. Second, national value chains extend well beyond the boundaries of their geographical clusters. Looking at the rural role only within geographical clusters still overlooks most of the rural contribution to national value chains. Third, focusing on the value chain nationally reveals the full contribution of rural areas. Paying attention to the primary industries at the core of the value chains, moreover, reveals that rural counties are central to a great range of the nation's value chains. Policies designed to help keep the nation competitive must not overlook the rural contribution to these production systems.

Although spatial externalities and agglomeration economies are becoming increasingly important to modern industry, as hypothesized in much of the recent regional research literature, there remains significant geographic variation in the U.S. industrial base, including a diverse mix of activity in rural and mixed rural counties. It is often believed that the typical rural economy specializes in a limited number of natural resource-based industries, supplemented with the occasional manufacturing branch plant nearing the end of its product cycle. However, our recasting of the industrial categories into value chains shows that there are few U.S. economic clusters that do not extend, in some fashion, into rural America. The fact that we did *not* find that only natural-resource based chains have a significant presence in rural counties is significant, as it implies a degree of locational flexibility across the industrial base—from manufacturing to services to advanced technology industries—that is easily forgotten in the rush to find distinct and spatially concentrated regional clusters. Rural policymakers would do well to avoid focusing solely on building locally-anchored clusters. Leveraging external linkages—whether it is with an urban-based cluster nearby or a national or global cluster—is also a "cluster" strategy.

Notes

[1] Additional details on the methodology are available in Feser (2005).

[2] In practice, the *R* measures are derived from 0/1 matrices where a positive dollar flow (or a flow exceeding a specified threshold) between sectors *i* and *j* is assigned a 1.

[3] All data manipulation and clustering algorithms were implemented in SAS software, principally the Interactive Matrix Language (IML) module.

[4] An alternative to weighting the enabling sectors would be to drop them from the linkage matrix (set their weight to zero) and then include them in a second stage identification of secondary cluster industries. However, that would preclude such industries from forming the core of their own value chains, a serious disadvantage.

[5] The distinctiveness of the clusters formed by the various splits in a clustering algorithm is an important criterion for selecting an appropriate solution. In the present analysis, the 43 cluster solution separated distinct subsets of aerospace and instruments industries into two groups. The 44 cluster solution, however, separated two groups of miscellaneous paper industries. Checking the underlying purchasing and sales patterns, while we could detect clear differences in input-output linkages among the aerospace and instruments industries separated in the 43 cluster solution, the same cannot be said for the two paper industry groups. Subsequent cluster solutions (45, 46, 47, etc.) similarly split sectors whose similarities in linkages appear stronger than their differences.

[6] An Excel file containing the full set of value chain definitions is available for download: http://www.urban.uiuc.edu/faculty/feser/publications.html.

[7] Based on data from the Covered Wages and Employment (ES-202) Series of the U.S. Bureau of Labor Statistics, and thus excluding sole proprietorships and a small number of other sectors not covered under employment security law.

[8] The employment data are from a 2002 *County Business Patterns* dataset that has been corrected for data suppression using the methods described in Isserman and Westervelt (2006). *County Business Patterns* data exclude farm workers, as well as government employees and selected other institutional employment categories.

[9] To do this we use the same *County Business Patterns* data used in the previous section. Therefore, the trends we describe refer only to the private nonfarm sector activity of various value chains. That excludes a significant amount of employment in the farming chain and relatively small amounts in the feed products, tobacco, grain milling, and dairy products chains.

[10] These differences in the spatial and functional characteristics of geographic clusters of value chain activity might stem from differences in production technologies and, therefore, industrial interdependence across regions. For example, we know that Japanese automobile producers have consistently favored locations in the Southeast and utilize a more highly networked, vertically disintegrated production model than Detroit-based U.S. automakers. At the 400-plus sectoral detail of the national input-output system, the value chains may be aggregated enough in their definition to

mitigate the problem. Although the data do not exist to examine regional differences in production technology systematically, there is enough evidence to know differences exist (Jackson 2000). Exploring the extent to which the national chain definitions obscure important regional technology differences would be worthwhile, perhaps through a case study approach. If the value chains are defined incorrectly, so, too, may be the regional clusters.

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Table 1

U.S. motor vehicles value chain

ID Code	IO Code	IO Label	2002 NAICS	Primary ID	Type	Linkage	Z-Score
23	336120	Heavy duty truck manufacturing	336120	23	Primary	0.51318	6.65
23	336211	Motor vehicle body manufacturing	336211	23	Primary	0.51100	6.62
23	336212	Truck trailer manufacturing	336212	23	Primary	0.50285	6.48
23	336110	Automobile & light truck manufacturing	336110	23	Primary	0.49863	6.41
23	336213	Motor home manufacturing	336213	23	Primary	0.46566	5.86
23	336214	Travel trailer & camper manufacturing	336214	23	Primary	0.44360	5.50
23	336300	Motor vehicle parts manufacturing	336300	16	Secondary	0.40194	4.81
23	336991	Motorcycle, bicycle, & parts manufacturing	336991	19	Secondary	0.34128	3.80
23	336999	All other transportation equipment manufacturing	336999	0	Secondary	0.29329	3.00
23	336612	Boat building	336612	0	Secondary	0.27436	2.69
23	334300	Audio & video equipment manufacturing	334300	12	Secondary	0.25887	2.43
23	335110	Electric lamp bulb and part manufacturing	335110	0	Secondary	0.17931	1.11

ID Code	A unique ID assigned to each (1,. . .45) identified value chain cluster
IO Code & Label	Input-output classification code, *Benchmark Input-Output Accounts of the United States, 1997*
2002 NAICS	2002 NAICS code (does not always concord directly to IO code)
Primary ID	Indicates the value chain cluster in which row sector is a *primary* member
Type	Indicates whether industry is *primary* or *secondary* to the value chain
Linkage & Z Score	Measures of strength of the sector's linkage to overall chain (higher value = stronger linkage)

Table 2

Forty-five U.S. value chains

Number of 2002 NAICS industries represented wholly or partially in each chain

ID	Value chain	2 digit	3 digit	4 digit	5 digit	6 digit
1	Textiles & apparel	3	6	12	22	49
2	Packaged food products	1	2	8	18	33
3	Plastics & rubber manufacturing	1	4	9	15	25
4	Aluminum & aluminum products	1	4	9	12	24
5	Basic health services	6	9	38	119	142
6	Mining	2	3	5	10	28
7	Farming	2	4	8	23	38
8	Construction	2	2	4	14	15
9	Financial services & insurance	5	10	22	68	91
10	Chemical-based products	3	7	11	18	31
11	Machine tools	1	4	12	14	34
12	Precision instruments	1	4	6	7	16
13	Printing & publishing	4	6	7	19	31
14	Metalworking & fabricated metal goods	1	3	6	9	18
15	Dairy products	2	2	5	9	14
16	Nondurable industry machinery	2	4	10	21	43
17	Computer & electronic equipment	2	4	8	10	31
18	Wood products & furniture	2	3	4	6	14
19	Construction machinery & distrb equip	1	3	8	13	29
20	Wood processing	4	4	7	10	20
21	Paper	1	4	4	9	24
22	Concrete, brick building products	2	8	16	22	26
23	Motor vehicles	1	3	7	15	23
24	Wood building products	2	8	15	19	27
25	Plastics products	1	2	3	10	18
26	Feed products	4	8	21	40	55
27	Arts & media	8	17	47	137	153
28	Mgmt, higher education & hospitals	13	20	69	178	213
29	Information services	5	11	38	104	121
30	Petroleum & gas	5	7	15	25	39
31	Business services	10	17	54	173	204
32	Grain milling	2	3	4	9	14
33	Rubber products	2	5	7	12	20
34	Glass products	2	2	5	6	18
35	Pharmaceuticals	2	3	8	9	14
36	Steel milling	1	2	4	5	7
37	Nonresidential building products	3	10	17	28	39
38	Tobacco products	2	2	2	3	4
39	Optical equipment & instruments	2	6	7	10	18
40	Appliances	2	7	16	20	30
41	Copper & copper products	1	3	6	8	17
42	Hotels	10	15	41	75	110
43	Aerospace	1	2	2	2	7
44	Breweries	2	4	4	7	11
45	Leather products	2	6	8	8	19

Note: Value chains are not mutually exclusive.

Table 3

Population and shares by Beale code, 2000

Code	Description	Total pop	Percent of total	Rural pop	Percent of rural	Farm pop	Percent of farm	n	Avg pop	Percent rural pop	Percent farm pop
Metropolitan											
1	County in metro area with 1 million population or more	149,224,067	53.0	11,161,799	18.9	378,362	12.7	413	361,317	7.5	0.3
2	County in metro area of 250,000 to 1 million population	55,514,159	19.7	10,566,581	17.9	411,271	13.8	325	170,813	19.0	0.7
3	County in metro area of fewer than 250,000 population	27,841,714	9.9	8,448,344	14.3	409,412	13.7	351	79,321	30.3	1.5
Nonmetropolitan											
4	Nonmetro county with urban population of 20,000 or more, adjacent to a metro area	14,442,161	5.1	6,676,168	11.3	281,556	9.4	218	66,248	46.2	1.9
5	Nonmetro county with urban population of 20,000 or more, not adjacent to a metro area	5,573,273	2.0	2,004,446	3.4	110,629	3.7	105	53,079	36.0	2.0
6	Nonmetro county with urban population of 2,500-19,999, adjacent to a metro area	15,134,357	5.4	9,959,795	16.9	635,038	21.3	609	24,851	65.8	4.2
7	Nonmetro county with urban population of 2,500-19,999, not adjacent to a metro area	8,463,700	3.0	5,054,629	8.6	361,278	12.1	450	18,808	59.7	4.3
8	Nonmetro county completely rural or less than 2,500 urban population, adj. to metro area	2,425,743	0.9	2,410,490	4.1	163,608	5.5	235	10,322	99.4	6.7
9	Nonmetro county completely rural or less than 2,500 urban population, not adj. to metro area	2,802,732	1.0	2,781,345	4.7	236,377	7.9	435	6,443	99.2	8.4

Source: U.S. Census and authors' calculations.

Table 4

Population and shares by rural and urban density code

County Type	Total	Percent of total	Rural	Percent of rural	Farm	Percent of farm	n	Avg pop	Percent Rural	Percent Farm
Rural	27,964,452	9.9	21,278,343	36.0	1,415,199	47.4	1,790	15,623	76.1	5.1
Mixed Rural	86,424,633	30.7	28,677,701	48.6	1,310,653	43.9	1,022	84,564	33.2	1.5
Mixed Urban	40,508,685	14.4	6,055,353	10.3	180,634	6.0	157	258,017	14.9	0.4
Urban	126,524,136	45.0	3,052,200	5.2	81,045	2.7	172	735,605	2.4	0.1
Total	281,421,906	100.0	59,063,597	100.0	2,987,531	100.0	3,141	1,093,809	21.0	1.1

Source: U.S. Census and authors' calculations.

Table 5

Rural population and shares by metro designation, 2000

Type	Metro status	Total pop	Percent of total	Rural pop	Percent of rural	Farm pop	Percent of farm	n	Avg pop	Percent Rural	Percent Farm
Rural	Metro	6,589,186	2.3	5,134,419	8.7	285,576	9.6	304	21,675	77.9	4.3
Rural	Non-metro	21,375,266	7.6	16,143,924	27.3	1,129,623	37.8	1,486	14,384	75.5	5.3
Mixed Rural	Metro	59,132,936	21.0	15,971,278	27.0	652,240	21.8	467	126,623	27.0	1.1
Mixed Rural	Non-metro	27,291,697	9.7	12,706,423	21.5	658,413	22.0	555	49,174	46.6	2.4
Mixed Urban	Metro	40,333,682	14.3	6,018,827	10.2	180,184	6.0	146	276,258	14.9	0.4
Mixed Urban	Non-metro	175,003	0.1	36,526	0.1	450	0.0	11	15,909	20.9	0.3
Urban	Metro	126,524,136	45.0	3,052,200	5.2	81,045	2.7	172	735,605	2.4	0.1
Total		281,421,906	100.0	59,063,597	100.0	2,987,531	100.0	3,141	1,239,630	21.0	1.1

Source: U.S. Census and authors' calculations.

Table 6

Rural-urban employment distribution of NAICS 2-digit sectors, 2002

		Rural		Mixed Rural		Mixed Urban		Urban	
NAICS Industry		Pct Emp	LQ	Pct Emp	LQ	Pct Emp	LQ	Pct Emp	LQ
11	Forestry, fishing, hunting, and agriculture support	32.3	5.6	48.0	1.9	7.3	0.5	12.4	0.2
21	Mining	24.2	4.2	34.5	1.3	6.5	0.4	16.1	0.3
22	Utilities	12.2	2.1	30.9	1.2	14.1	1.0	42.2	0.8
23	Construction	5.9	1.0	29.4	1.1	16.3	1.1	48.1	0.9
31	Manufacturing	10.2	1.8	33.7	1.3	15.9	1.1	40.2	0.8
42	Wholesale trade	4.5	0.8	20.9	0.8	14.1	1.0	60.3	1.1
44	Retail trade	7.1	1.2	31.0	1.2	15.9	1.1	45.7	0.9
48	Transportation & warehousing	5.1	0.9	22.4	0.9	13.7	0.9	58.7	1.1
51	Information	2.9	0.5	17.7	0.7	12.5	0.9	66.0	1.3
52	Finance & insurance	3.6	0.6	18.1	0.7	12.7	0.9	65.3	1.2
53	Real estate & rental & leasing	3.2	0.6	21.7	0.8	13.4	0.9	61.3	1.2
54	Professional, scientific & technical services	2.4	0.4	15.8	0.6	12.5	0.9	67.7	1.3
55	Management of companies & enterprises	1.6	0.3	14.3	0.6	13.3	0.9	70.5	1.3
56	Admin, support, waste mgt, remediation services	2.1	0.4	18.2	0.7	13.1	0.9	57.4	1.1
61	Educational services	3.8	0.7	20.1	0.8	12.0	0.8	62.4	1.2
62	Health care and social assistance	6.5	1.1	28.5	1.1	14.5	1.0	50.1	1.0
71	Arts, entertainment & recreation	5.5	1.0	26.4	1.0	14.7	1.0	53.0	1.0
72	Accommodation & food services	6.4	1.1	31.4	1.2	15.2	1.0	46.6	0.9
81	Other services (except public administration)	5.4	0.9	26.3	1.0	14.9	1.0	52.3	1.0
95	Auxiliaries (exc corporate, subsidiary & regional mgt)	3.0	0.5	21.6	0.8	14.1	1.0	60.7	1.2
99	Unclassified establishments	10.0	1.7	28.0	1.1	16.1	1.1	45.4	0.9
Total non-farm private employment		5.8	1.0	25.9	1.0	14.4	1.0	52.7	1.0

Source: Enhanced 2002 *County Business Patterns* (Isserman and Westervelt 2006) and authors' calculations. Location quotients of 1.2 or greater highlighted.

Table 7

Employment in each county type, 2002

NAICS Industry		Pct of county type employment: Rural	Mixed rural	Mixed urban	Urban	Rural-urban difference
62	Manufacturing	22.5	16.7	14.1	9.8	12.8
31	Retail trade	16.2	15.8	14.6	11.4	4.8
44	Health care and social assistance	14.9	14.6	13.3	12.6	2.3
23	Accommodation & food services	9.8	10.8	9.4	7.9	1.9
52	Construction	5.7	6.4	6.3	5.1	0.6
81	Other services (except public administration)	4.5	4.9	5.0	4.8	-0.3
42	Wholesale trade	4.1	4.2	5.1	6.0	-1.9
54	Finance & insurance	3.5	4.0	5.0	7.1	-3.5
51	Transportation & warehousing	2.8	2.8	3.0	3.6	-0.8
56	Admin, support, waste mgt, remediation services	2.8	5.2	6.7	8.1	-5.3
72	Professional, scientific & technical services	2.6	3.8	5.4	8.1	-5.5
21	Mining	2.3	0.6	0.2	0.1	2.2
61	Educational services	1.8	1.9	2.0	2.8	-1.0
48	Information	1.6	2.1	2.7	3.9	-2.3
71	Arts, entertainment & recreation	1.6	1.6	1.6	1.6	-0.1
22	Utilities	1.3	0.7	0.6	0.5	0.8
95	Auxiliaries (exc corporate, subsidiary & regional mgt)	1.1	0.8	0.9	1.0	0.1
53	Real estate & rental & leasing	1.0	1.5	1.7	2.1	-1.1
11	Forestry, fishing, hunting, and agriculture support	1.0	0.3	0.1	0.0	0.9
55	Management of companies & enterprises	1.0	1.4	2.4	3.5	-2.5
99	Unclassified establishments	0.1	0.0	0.0	0.0	0.0
Total		100.0	100.0	100.0	100.0	0.0

Source: Enhanced 2002 *County Business Patterns* (Isserman and Westervelt 2006) and authors' calculations.

Table 8

Rural-urban distribution of U.S. value chains, 2002

Sorted in descending order of rural & mixed rural percentage

ID	Cluster	Emp (000s)	Percent of total U.S. value chain employment: Rural	Mixed Rural	Mixed Urban	Urban	Rural & Mixed Rural	Mixed Urban & Urban
6	Mining	274.6	35.5	44.4	8.6	11.5	79.9	20.1
26	Feed products	301.1	23.0	47.2	10.4	19.5	70.1	29.9
32	Grain milling	44.9	17.5	47.2	9.5	25.8	64.7	35.3
20	Wood processing	1,017.6	24.3	40.2	12.7	22.8	64.5	35.5
10	Chemical-based products	484.1	17.1	46.5	14.5	21.9	63.6	36.4
7	Farming	12.8	17.6	40.8	6.6	35.0	58.4	41.6
22	Concrete, brick building products	755.1	14.9	40.8	15.8	28.6	55.6	44.4
24	Wood building products	857.9	15.5	39.9	15.5	29.1	55.4	44.6
18	Wood products & furniture	650.6	18.4	36.3	18.6	26.6	54.7	45.3
2	Packaged food products	1,284.8	14.8	39.7	11.8	33.6	54.6	45.4
3	Plastics & rubber manufacturing	632.7	12.4	40.8	15.5	31.3	53.2	46.8
40	Appliances	995.0	13.1	39.5	15.5	31.9	52.6	47.4
1	Textiles & apparel	952.7	15.9	35.4	13.6	35.1	51.3	48.7
23	Motor vehicles	1,104.3	11.1	37.9	18.7	32.4	49.0	51.0
19	Construction machinery & distrb equip	594.5	11.1	37.6	16.0	35.3	48.7	51.3
33	Rubber products	537.9	8.2	39.6	13.9	38.3	47.8	52.2
15	Dairy products	246.0	14.1	33.6	15.7	36.6	47.6	52.4
45	Leather products	169.0	14.8	32.4	13.2	39.5	47.3	52.7
34	Glass products	354.0	8.1	38.7	15.9	37.4	46.8	53.2
25	Plastics products	894.7	10.2	36.3	17.4	36.1	46.5	53.5
16	Nondurable industry machinery	1,653.9	10.2	35.4	17.1	37.3	45.6	54.4
14	Metalworking & fabricated metal goods	702.3	9.2	34.7	16.0	40.1	43.9	56.1
44	Breweries	316.3	6.7	36.9	14.3	42.2	43.6	56.4
4	Aluminum & aluminum products	679.8	8.8	34.5	20.2	36.5	43.3	56.7
30	Petroleum & gas	1,343.1	10.3	33.0	13.5	43.2	43.3	56.7
36	Steel milling	220.3	7.5	34.5	25.5	32.4	42.0	58.0
41	Copper & copper products	238.3	8.1	32.6	18.8	40.4	40.8	59.2
11	Machine tools	1,154.7	8.6	31.8	16.2	43.4	40.4	59.6
21	Paper	538.1	6.0	31.9	16.2	45.9	37.9	62.1
12	Precision instruments	383.2	5.5	30.5	15.9	48.1	36.0	64.0
8	Construction	6,365.5	6.2	29.6	16.4	47.8	35.9	64.1
37	Nonresidential building products	2,215.8	6.3	26.7	15.8	51.1	33.0	67.0
39	Optical equipment & instruments	420.5	5.1	27.1	14.9	52.9	32.2	67.8
28	Mgmt, higher education & hospitals	30,650.2	4.7	22.7	13.4	59.2	27.4	72.6
42	Hotels	19,848.7	3.9	21.2	13.3	61.5	25.2	74.8
5	Basic health services	21,502.8	3.6	21.4	14.3	60.8	25.0	75.0
35	Pharmaceuticals	461.9	4.1	20.2	13.8	61.8	24.4	75.6
27	Arts & media	14,665.3	3.7	19.9	13.4	63.0	23.6	76.4
31	Business services	27,471.8	3.4	19.5	13.3	63.8	22.9	77.1
13	Printing & publishing	2,779.2	3.3	19.3	12.6	64.8	22.6	77.4
17	Computer & electronic equipment	1,447.1	2.4	19.4	17.2	60.9	21.9	78.1
29	Information services	13,329.6	3.2	17.7	13.1	66.0	20.9	79.1
9	Financial services & insurance	15,611.2	2.8	17.9	13.2	66.1	20.7	79.3
43	Aerospace	554.5	1.7	17.8	18.6	61.9	19.5	80.5
38	Tobacco products	24.0	1.9	15.8	30.8	51.5	17.7	82.3

Source: Enhanced 2002 *County Business Patterns* (Isserman and Westervelt 2006) and authors' calculations. Includes private nonfarm employment only (note that there is significant farm employment in the farming and feed products chains, and small amounts of farm employment in the dairy products, wood processing, grain milling, and tobacco products chains).

Table 9

Rural-urban distribution of U.S. value chain primary industry employment, 2002

Sorted in descending order of rural & mixed rural percentage

			Percent of U.S. value chain employment in primary industries					
ID	Cluster	Emp (000s)	Rural	Mixed Rural	Mixed Urban	Urban	Rural & Mixed Rural	Mixed Urban & Urban
6	Mining	202.4	40.5	42.9	7.2	9.4	83.4	16.6
20	Wood processing	269.2	36.8	45.8	7.8	9.6	82.6	17.4
26	Feed products	156.1	22.2	51.2	10.3	16.4	73.3	26.7
10	Chemical-based products	336.5	20.0	47.6	12.9	19.5	67.6	32.4
24	Wood building products	191.7	23.5	41.6	17.1	17.8	65.1	34.9
32	Grain milling	40.8	17.9	45.8	9.9	26.4	63.6	36.4
22	Concrete, brick building products	202.8	12.9	41.6	15.2	30.2	54.5	45.5
2	Packaged food products	1,246.3	14.4	40.0	11.9	33.7	54.4	45.6
15	Dairy products	129.3	13.3	40.4	14.5	31.8	53.7	46.3
19	Construction machinery & distrb equip	404.3	13.3	38.8	15.5	32.4	52.1	47.9
41	Copper & copper products	64.2	9.1	41.8	20.9	28.2	50.9	49.1
18	Wood products & furniture	446.2	14.8	35.8	18.9	30.5	50.6	49.4
33	Rubber products	449.0	8.9	41.3	13.9	35.9	50.2	49.8
1	Textiles & apparel	841.3	14.5	34.8	12.4	38.2	49.4	50.6
4	Aluminum & aluminum products	346.4	11.5	37.8	18.2	32.5	49.3	50.7
3	Plastics & rubber manufacturing	266.8	8.8	40.4	15.6	35.2	49.1	50.9
45	Leather products	47.8	15.4	32.8	13.1	38.7	48.3	51.7
25	Plastics products	762.7	10.6	35.4	18.1	35.9	46.0	54.0
40	Appliances	412.3	9.3	36.6	15.6	38.5	45.9	54.1
16	Nondurable industry machinery	1,163.7	9.8	35.8	17.6	36.7	45.6	54.4
14	Metalworking & fabricated metal goods	533.8	9.6	35.8	15.9	38.7	45.4	54.6
23	Motor vehicles	331.3	8.5	35.9	18.5	37.0	44.5	55.5
34	Glass products	305.1	6.8	37.2	16.2	39.8	44.0	56.0
30	Petroleum & gas	1,122.6	10.4	31.7	13.3	44.6	42.1	57.9
11	Machine tools	1,067.6	8.3	31.6	16.3	43.8	39.9	60.1
37	Nonresidential building products	222.3	6.9	31.2	18.5	43.3	38.2	61.8
21	Paper	394.5	5.6	30.8	17.1	46.5	36.4	63.6
12	Precision instruments	253.3	6.2	30.0	17.1	46.7	36.3	63.7
36	Steel milling	163.9	4.8	30.8	29.8	34.6	35.6	64.4
44	Breweries	36.8	4.3	27.4	12.6	55.7	31.7	68.3
42	Hotels	7,488.5	5.2	25.9	13.9	55.0	31.1	68.9
39	Optical equipment & instruments	372.4	4.8	25.9	14.5	54.8	30.7	69.3
28	Mgmt, higher education & hospitals	16,708.0	5.2	24.0	13.5	57.2	29.2	70.8
13	Printing & publishing	1,326.3	4.5	24.3	13.9	57.3	28.8	71.2
5	Basic health services	8,667.2	3.6	23.7	15.1	57.6	27.3	72.7
31	Business services	15,531.9	3.9	19.5	13.5	63.1	23.4	76.6
27	Arts & media	1,168.5	2.7	19.4	11.3	66.7	22.0	78.0
17	Computer & electronic equipment	1,093.6	2.2	19.3	17.8	60.6	21.6	78.4
43	Aerospace	371.3	1.4	19.9	19.4	59.3	21.2	78.8
35	Pharmaceuticals	340.3	3.8	17.0	13.6	65.6	20.8	79.2
38	Tobacco products	24.0	1.9	15.8	30.8	51.5	17.7	82.3
9	Financial services & insurance	3,375.6	1.8	15.3	12.1	70.8	17.1	82.9
29	Information services	2,990.7	1.8	13.4	13.2	71.5	15.3	84.7
7	Farming	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	Construction	---	---	---	---	---	---	---

Source: Enhanced 2002 *County Business Patterns* (Isserman and Westervelt 2006) and authors' calculations. Value chains are not mutually exclusive. Includes private nonfarm employment only (note that there is significant farm employment in the farming and feed products chains, and small amounts of farm employment in the dairy products, wood processing, grain milling, and tobacco products chains). Primary versus total value chain employment cannot be distinguished for construction due to non-direct concordance between input-output and 1997 NAICS classifications.

Table 10

Percent of county type's value chain employment in higher wage industries, 2002

Sorted in descending order by rural & mixed rural percentage

ID	Cluster	Rural	Mixed Rural	Mixed Urban	Urban	Rural & Mixed Rural	Mixed Urban & Urban
39	Optical equipment & instruments	64.9	73.9	68.8	72.7	72.4	71.8
30	Petroleum & gas	77.1	71.0	67.3	68.9	72.4	68.5
10	Chemical-based products	69.6	72.5	70.6	78.7	71.7	75.5
6	Mining	72.9	67.7	48.7	48.0	70.0	48.3
3	Plastics & rubber manufacturing	75.0	68.2	56.8	56.6	69.8	56.7
43	Aerospace	55.5	68.1	65.7	67.3	67.0	66.9
21	Paper	56.1	65.1	68.4	64.6	63.7	65.6
17	Computer & electronic equipment	43.3	64.6	62.3	71.1	62.2	69.2
38	Tobacco products	68.5	59.9	98.4	96.1	60.8	97.0
1	Textiles & apparel	49.5	62.2	60.2	43.1	58.3	47.9
45	Leather products	53.0	57.3	48.2	42.8	56.0	44.2
32	Grain milling	40.4	61.2	91.4	90.3	55.6	90.6
36	Steel milling	41.0	58.6	82.6	72.1	55.4	76.7
4	Aluminum & aluminum products	54.9	55.5	59.7	50.3	55.4	53.6
37	Nonresidential building products	37.2	59.4	69.9	80.2	55.2	77.8
29	Information services	45.8	55.5	63.3	65.4	54.0	65.1
35	Pharmaceuticals	48.1	53.9	53.5	59.7	52.9	58.6
44	Breweries	59.3	51.1	58.1	60.6	52.3	60.0
28	Mgmt, higher education & hospitals	43.0	52.6	59.6	64.0	51.0	63.2
41	Copper & copper products	47.4	50.9	36.8	20.6	50.2	25.7
19	Construction machinery & distrb equip	38.5	53.4	65.2	64.3	50.0	64.6
27	Arts & media	41.1	51.1	60.6	65.4	49.5	64.6
12	Precision instruments	29.8	53.1	67.2	83.1	49.5	79.2
20	Wood processing	47.6	49.5	50.6	58.3	48.8	55.5
31	Business services	45.7	47.2	54.4	59.3	47.0	58.5
5	Basic health services	41.6	46.8	49.5	51.6	46.0	51.2
23	Motor vehicles	32.6	49.0	53.8	68.7	45.3	63.3
9	Financial services & insurance	51.7	43.7	45.2	51.2	44.8	50.2
16	Nondurable industry machinery	36.6	45.8	49.4	52.3	43.8	51.4
33	Rubber products	28.2	46.5	46.4	54.1	43.3	52.0
34	Glass products	43.1	42.5	29.7	26.3	42.6	27.3
14	Metalworking & fabricated metal goods	37.0	41.6	46.0	39.4	40.7	41.3
42	Hotels	43.1	38.0	40.6	46.2	38.8	45.2
15	Dairy products	28.2	42.4	54.0	57.4	38.2	56.3
11	Machine tools	33.1	37.1	35.2	36.4	36.2	36.0
18	Wood products & furniture	30.6	36.1	48.0	49.0	34.2	48.6
24	Wood building products	24.1	37.2	42.0	49.7	33.5	47.0
40	Appliances	26.1	34.9	37.2	38.8	32.7	38.3
22	Concrete, brick building products	26.0	34.7	34.8	40.0	32.4	38.2
13	Printing & publishing	27.0	30.5	38.7	54.6	30.0	52.0
25	Plastics products	19.0	27.1	20.4	24.8	25.3	23.3
2	Packaged food products	15.1	28.3	44.4	55.2	24.7	52.3
26	Feed products	---	---	---	---	---	---
7	Farming	---	---	---	---	---	---
8	Construction	---	---	---	---	---	---

Source: Enhanced 2002 *County Business Patterns* (Isserman and Westervelt 2006) and authors' calculations. Value chains are not mutually exclusive. Includes private nonfarm employment only (note that there is significant farm employment in the farming and feed products chains, and small amounts of farm employment in the dairy products, wood processing, grain milling, and tobacco products chains). Higher wage value chain employment cannot be distinguished for construction, farming and feed products (construction due to non-direct concordance between input-output and 1997 NAICS classifications, and farming and feed products because (nonfarm) *County Business Patterns* data exclude the majority of component industries.

Table 11

Percent of county type's value chain employment that is non-metro

Sorted in descending order by rural & mixed rural percentage

ID	Cluster	Rural	Mixed Rural	Rural & Mixed Rural
6	Mining	84.0	46.6	63.2
20	Wood processing	82.6	44.8	59.0
26	Feed products	82.5	44.6	57.0
1	Textiles & apparel	81.8	45.2	56.5
7	Farming	93.5	39.9	56.0
18	Wood products & furniture	81.2	43.1	55.9
45	Leather products	83.7	42.7	55.6
2	Packaged food products	81.8	45.6	55.4
32	Grain milling	81.3	45.4	55.1
19	Construction machinery & distrb equip	82.8	45.4	54.0
15	Dairy products	82.7	41.7	53.9
40	Appliances	83.3	41.2	51.7
24	Wood building products	81.6	39.7	51.4
33	Rubber products	79.2	45.0	50.9
22	Concrete, brick building products	81.0	38.2	49.6
11	Machine tools	79.1	41.5	49.5
16	Nondurable industry machinery	80.4	40.5	49.4
10	Chemical-based products	76.5	39.1	49.2
23	Motor vehicles	80.2	39.0	48.4
34	Glass products	79.7	38.7	45.8
41	Copper & copper products	85.3	35.1	45.1
14	Metalworking & fabricated metal goods	74.5	36.0	44.1
25	Plastics products	77.7	34.6	44.0
12	Precision instruments	86.2	36.1	43.7
39	Optical equipment & instruments	72.4	38.1	43.6
4	Aluminum & aluminum products	82.9	32.5	42.7
3	Plastics & rubber manufacturing	73.4	33.3	42.7
38	Tobacco products	56.2	40.5	42.2
21	Paper	80.0	34.3	41.5
36	Steel milling	78.1	33.5	41.4
30	Petroleum & gas	78.4	29.6	41.2
37	Nonresidential building products	78.4	29.9	39.2
28	Higher education & hospitals	80.9	28.7	37.6
44	Breweries	74.5	29.8	36.6
13	Printing & publishing	77.6	29.5	36.5
35	Pharmaceuticals	73.1	28.1	35.7
27	Arts & media	80.4	27.0	35.5
42	Hotels	80.1	25.6	34.1
5	Basic health services	81.1	26.1	33.9
29	Information services	81.2	25.0	33.6
8	Construction	75.8	24.7	33.6
31	Business services	80.4	25.3	33.5
9	Financial services & insurance	80.9	23.8	31.4
17	Computer & electronic equipment	81.2	20.5	27.3
43	Aerospace	74.9	16.4	21.6

Source: Enhanced 2002 County Business Patterns (Isserman and Westervelt 2006) and authors' calculations. Value chains are not mutually exclusive. Includes private nonfarm employment only (note that there is significant farm employment in the farming and feed products chains, and small amounts of farm employment in the dairy products, wood processing, grain milling, and tobacco products chains).

Table 12

Fifteen motor vehicles spatial clusters

Total counties by type

Cluster	Rural	Mixed rural	Mixed urban	Urban	Total
Detroit	40	90	21	12	163
Kentucky	18	13	2	3	36
St. Louis	11	2	2	3	18
Nashville	9	9	0	1	19
Buffalo	4	4	2	1	11
San Francisco Bay Area	3	4	2	6	15
Chicago	2	12	6	7	27
Dallas	2	7	3	2	14
Kansas City	2	4	1	3	10
Carolina	1	11	1	0	13
Knoxville	1	4	1	0	6
Southern California	1	8	1	3	13
Atlanta	0	1	2	3	6
Newport	0	0	2	0	2
Pennsylvania	0	1	3	3	7
All fifteen	94	170	49	47	360

Table 13

Fifteen motor vehicles spatial clusters

Share of activity by county type, by sector type

County type	All cluster sectors	Primary sectors	Higher wage sectors
Percent share of 15 spatial cluster establishments			
Rural	4.8	5.6	4.4
Mixed rural	27.1	31.9	25.3
Mixed urban	18.7	28.3	16.1
Urban	49.5	34.2	54.2
Rural & mixed rural	31.8	37.5	29.7
Mixed urban & urban	68.2	62.5	70.3
Total	100.0	100.0	100.0
Percent share of 15 spatial cluster employment			
Rural	4.7	1.6	4.5
Mixed rural	32.9	26.3	32.4
Mixed urban	21.3	24.8	19.7
Urban	41.1	47.3	43.5
Rural & mixed rural	37.6	27.9	36.9
Mixed urban & urban	62.4	72.1	63.1
Total	100.0	100.0	100.0

Source: Enhanced 2002 *County Business Patterns* (Isserman and Westervelt 2006).

Table 14a

Rural-urban geography of motor vehicle spatial clusters, 2002

	Employ-ment (000s)	Percent share of spatial cluster employment						Percent share of spatial cluster establishments					
		Rural	Mixed Rural	Mixed Urban	Urban	Rural & Mixed Rural	Mixed Urban & Urban	Rural	Mixed Rural	Mixed Urban	Urban	Rural & Mixed Rural	Mixed Urban & Urban
Atlanta	7.9	0.0	2.0	11.8	86.2	2.0	98.0	0.0	5.7	14.3	80.0	5.7	94.3
Buffalo	18.7	4.2	12.1	29.5	54.2	16.4	83.6	4.3	17.4	20.3	58.0	21.7	78.3
Carolina	14.4	0.0	93.2	6.8	0.0	93.2	6.8	1.4	82.4	16.2	0.0	83.8	16.2
Chicago	35.2	0.4	33.4	9.9	56.3	33.8	66.2	0.3	12.3	13.7	73.7	12.6	87.4
Dallas	13.1	1.9	11.6	20.0	66.5	13.5	86.5	3.5	21.5	12.0	63.0	25.0	75.0
Detroit	428.0	5.0	33.2	25.7	36.1	38.2	61.8	7.6	30.8	26.5	35.1	38.3	61.7
Kansas City	11.1	0.1	1.4	53.8	44.6	1.6	98.4	1.6	7.9	12.7	77.8	9.5	90.5
Kentucky	35.7	8.5	50.4	5.3	35.8	58.9	41.1	11.1	38.9	9.3	40.7	50.0	50.0
Knoxville	11.2	20.1	48.9	31.0	0.0	69.0	31.0	18.9	37.7	43.4	0.0	56.6	43.4
Nashville	18.5	14.3	81.6	0.0	4.1	95.9	4.1	13.8	67.0	0.0	19.1	80.9	19.1
Newport	3.0	0.0	0.0	100.0	0.0	0.0	100.0	0.0	0.0	100.0	0.0	0.0	100.0
Pennsylvania	12.0	0.0	0.0	32.5	67.5	0.0	100.0	0.0	0.0	56.0	44.0	0.0	100.0
SF Bay Area	12.8	0.3	11.0	9.8	78.9	11.3	88.7	0.4	12.2	13.9	73.4	12.7	87.3
Southern California	40.1	0.4	28.9	3.2	67.5	29.3	70.7	0.2	26.2	3.6	70.0	26.4	73.6
St. Louis	18.6	6.9	5.9	3.2	84.0	12.8	87.2	11.5	20.8	8.3	59.4	32.3	67.7
All fifteen	680.3	4.7	32.9	21.3	41.1	37.6	62.4	4.8	27.1	18.7	49.5	31.8	68.2

Source: Enhanced 2002 *County Business Patterns* (Isserman and Westervelt 2006).

Table 14b

Rural-urban geography of motor vehicle spatial cluster, primary industries, 2002

	Primary employ-ment (000s)	Percent share of primary sector employment						Percent share of primary sector establishments					
		Rural	Mixed Rural	Mixed Urban	Urban	Rural & Mixed Rural	Mixed Urban & Urban	Rural	Mixed Rural	Mixed Urban	Urban	Rural & Mixed Rural	Mixed Urban & Urban
Atlanta	5.9	0.0	2.7	0.0	97.3	2.7	97.3	0.0	22.2	11.1	66.7	22.2	77.8
Buffalo	0.2	0.0	0.0	32.4	67.6	0.0	100.0	0.0	0.0	25.0	75.0	0.0	100.0
Carolina	5.4	0.0	99.1	0.9	0.0	99.1	0.9	0.0	82.4	17.6	0.0	82.4	17.6
Chicago	10.8	1.2	61.8	3.8	33.3	62.9	37.1	2.0	25.5	19.6	52.9	27.5	72.5
Dallas	5.5	2.2	10.4	23.6	63.7	12.7	87.3	10.3	36.2	13.8	39.7	46.6	53.4
Detroit	112.6	2.6	19.3	37.7	40.5	21.8	78.2	8.0	27.6	44.6	19.8	35.6	64.4
Kansas City	8.3	0.2	0.0	64.9	34.9	0.2	99.8	7.7	7.7	30.8	53.8	15.4	84.6
Kentucky	17.6	0.0	43.7	0.1	56.3	43.7	56.3	7.1	42.9	7.1	42.9	50.0	50.0
Knoxville	0.3	17.7	79.9	2.4	0.0	97.6	2.4	27.3	36.4	36.4	0.0	63.6	36.4
Nashville	6.9	0.0	92.6	0.0	7.4	92.6	7.4	0.0	78.6	0.0	21.4	78.6	21.4
Newport	0.0	0.0	0.0	100.0	0.0	0.0	100.0	0.0	0.0	100.0	0.0	0.0	100.0
Pennsylvania	6.4	0.0	0.0	29.3	70.7	0.0	100.0	0.0	0.0	75.0	25.0	0.0	100.0
SF Bay Area	7.0	0.0	4.8	4.6	90.6	4.8	95.2	0.0	32.6	10.9	56.5	32.6	67.4
Southern California	10.3	1.6	56.4	0.1	41.9	58.0	42.0	1.2	42.8	1.7	54.3	43.9	56.1
St. Louis	12.3	0.3	1.6	0.4	97.7	1.9	98.1	13.0	30.4	17.4	39.1	43.5	56.5
All fifteen	209.6	1.6	26.3	24.8	47.3	27.9	72.1	5.6	31.9	28.3	34.2	37.5	62.5

Source: Enhanced 2002 *County Business Patterns* (Isserman and Westervelt 2006).

Table 14c

Rural-urban geography of motor vehicle spatial clusters, higher wage industries, 2002

	Employment (000s)	Percent share of spatial cluster employment						Percent share of spatial cluster establishments					
		Rural	Mixed Rural	Mixed Urban	Urban	Rural & Mixed Rural	Mixed Urban & Urban	Rural	Mixed Rural	Mixed Urban	Urban	Rural & Mixed Rural	Mixed Urban & Urban
Atlanta	7.6	0.0	0.0	12.1	87.9	0.0	100.0	0.0	0.0	14.3	85.7	0.0	100.0
Buffalo	18.3	4.3	12.4	29.8	53.5	16.8	83.2	5.8	23.1	21.2	50.0	28.8	71.2
Carolina	14.1	0.0	93.0	7.0	0.0	93.0	7.0	1.6	79.7	18.8	0.0	81.3	18.8
Chicago	32.8	0.0	34.5	9.1	56.4	34.5	65.5	0.0	11.2	11.8	77.0	11.2	88.8
Dallas	11.1	1.1	7.7	20.3	70.8	8.9	91.1	0.8	13.8	12.3	73.1	14.6	85.4
Detroit	391.6	4.8	33.0	23.4	38.8	37.8	62.2	7.4	30.5	22.5	39.7	37.9	62.1
Kansas City	11.0	0.0	1.4	54.1	44.5	1.4	98.6	0.0	6.0	10.0	84.0	6.0	94.0
Kentucky	35.3	8.6	50.7	5.4	35.3	59.4	40.6	11.2	37.8	10.2	40.8	49.0	51.0
Knoxville	8.4	13.1	56.6	30.4	0.0	69.6	30.4	6.9	34.5	58.6	0.0	41.4	58.6
Nashville	17.3	13.5	82.8	0.0	3.7	96.3	3.7	14.1	66.2	0.0	19.7	80.3	19.7
Newport	2.4	0.0	0.0	100.0	0.0	0.0	100.0	0.0	0.0	100.0	0.0	0.0	100.0
Pennsylvania	10.1	0.0	0.0	19.7	80.3	0.0	100.0	0.0	0.0	38.9	61.1	0.0	100.0
SF Bay Area	11.4	0.3	7.4	7.4	84.9	7.7	92.3	0.6	6.3	12.5	80.7	6.8	93.2
Southern California	28.6	0.0	17.2	4.5	78.4	17.2	82.8	0.0	20.9	3.9	75.1	20.9	79.1
St. Louis	18.2	6.8	4.8	3.0	85.4	11.6	88.4	8.6	15.7	5.7	70.0	24.3	75.7
All fifteen	618.1	4.5	32.4	19.7	43.5	36.9	63.1	4.4	25.3	16.1	54.2	29.7	70.3

Source: Enhanced 2002 *County Business Patterns* (Isserman and Westervelt 2006).

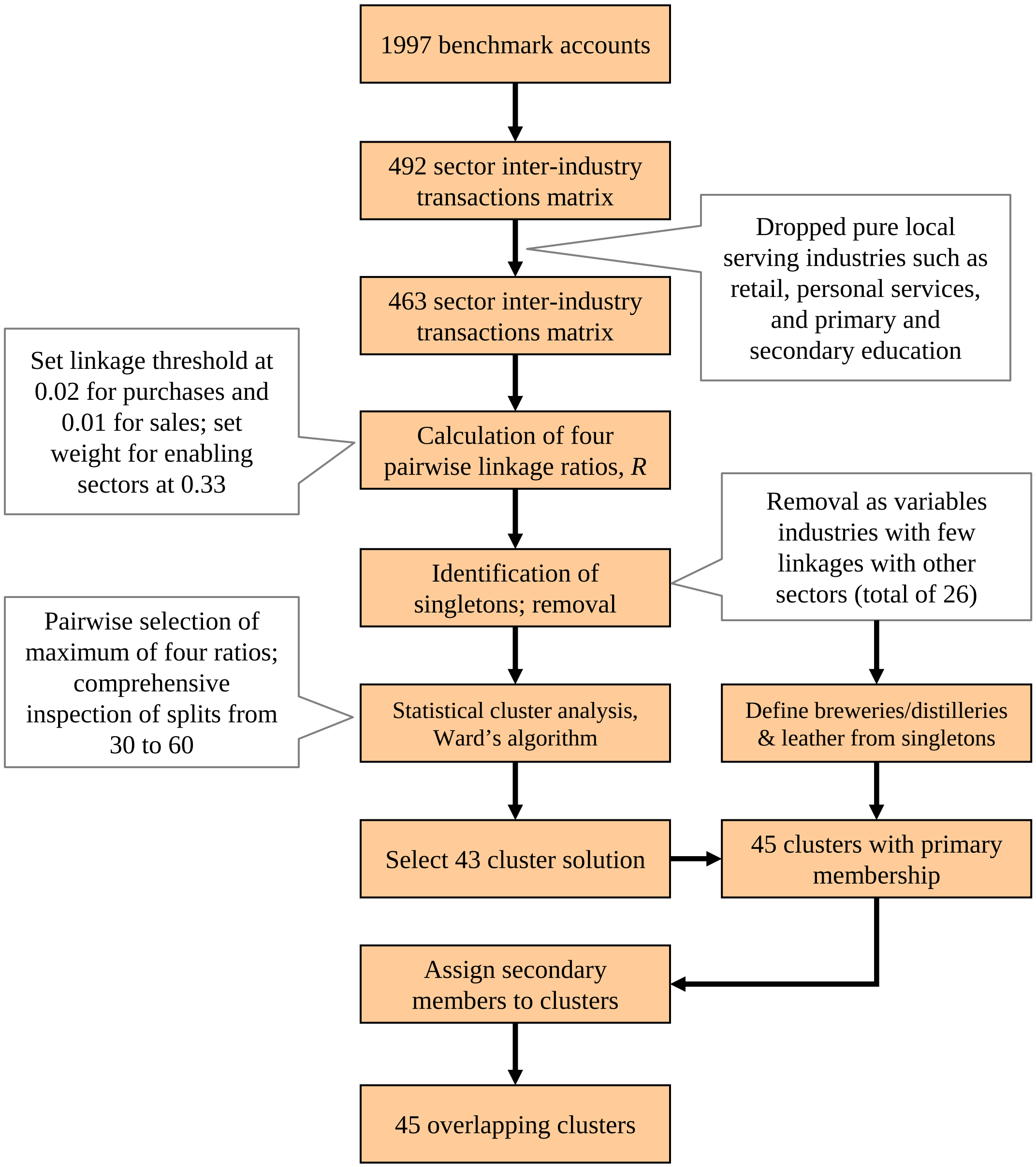


Figure 1. Benchmark cluster methodology

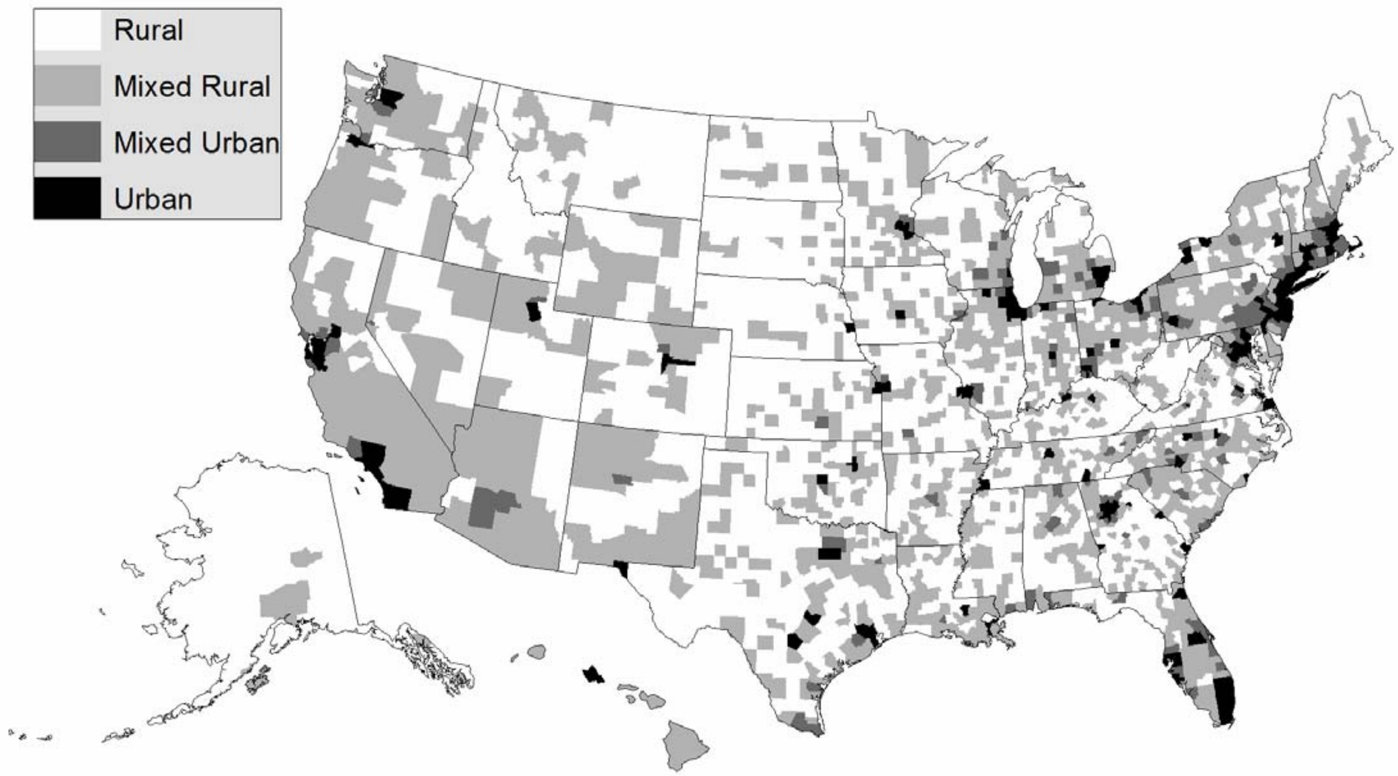


Figure 2. Rural-urban county typology

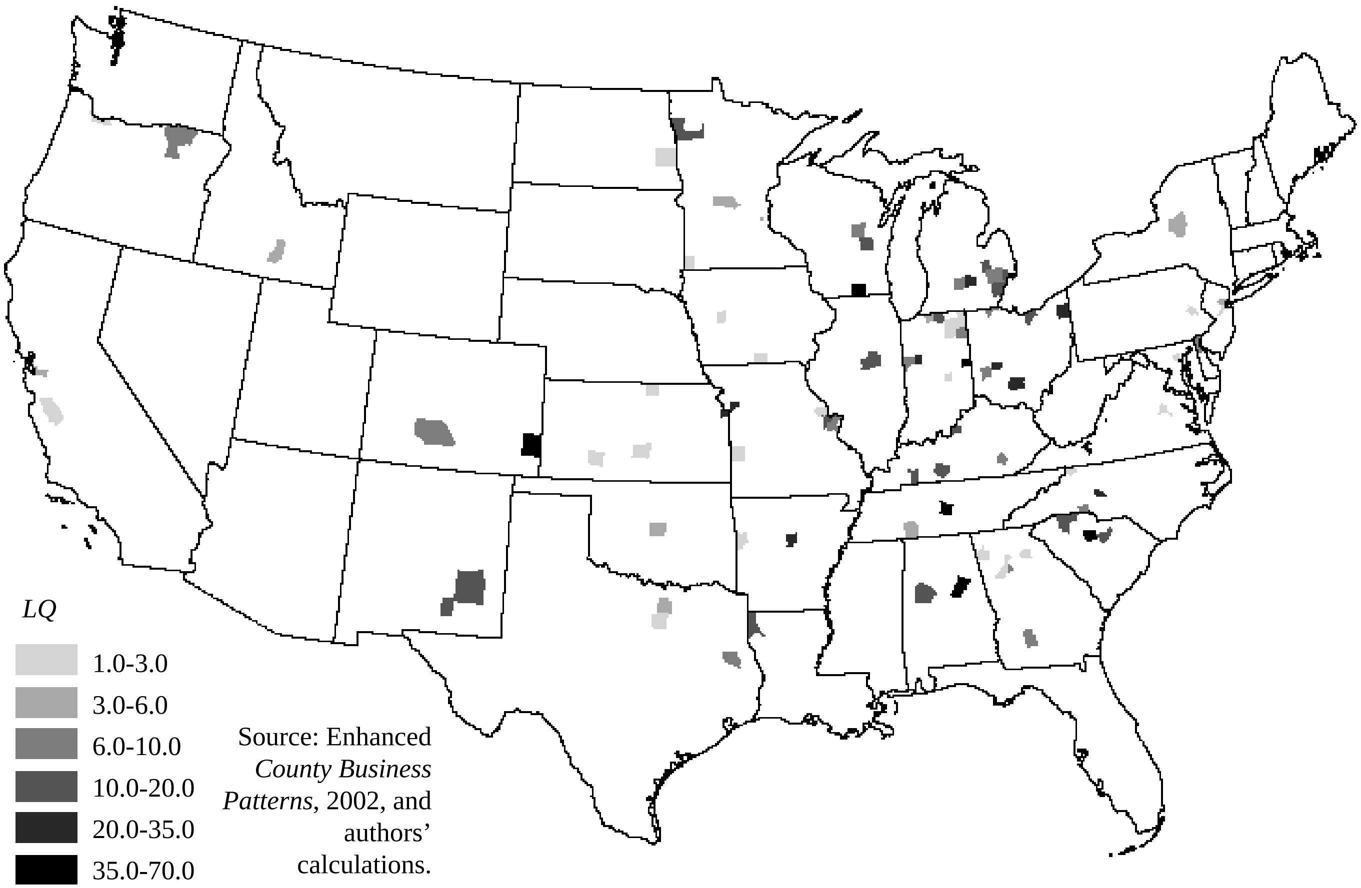


Figure 3. Employment location quotients by county, NAICS 3361 (motor vehicle manufacturing)

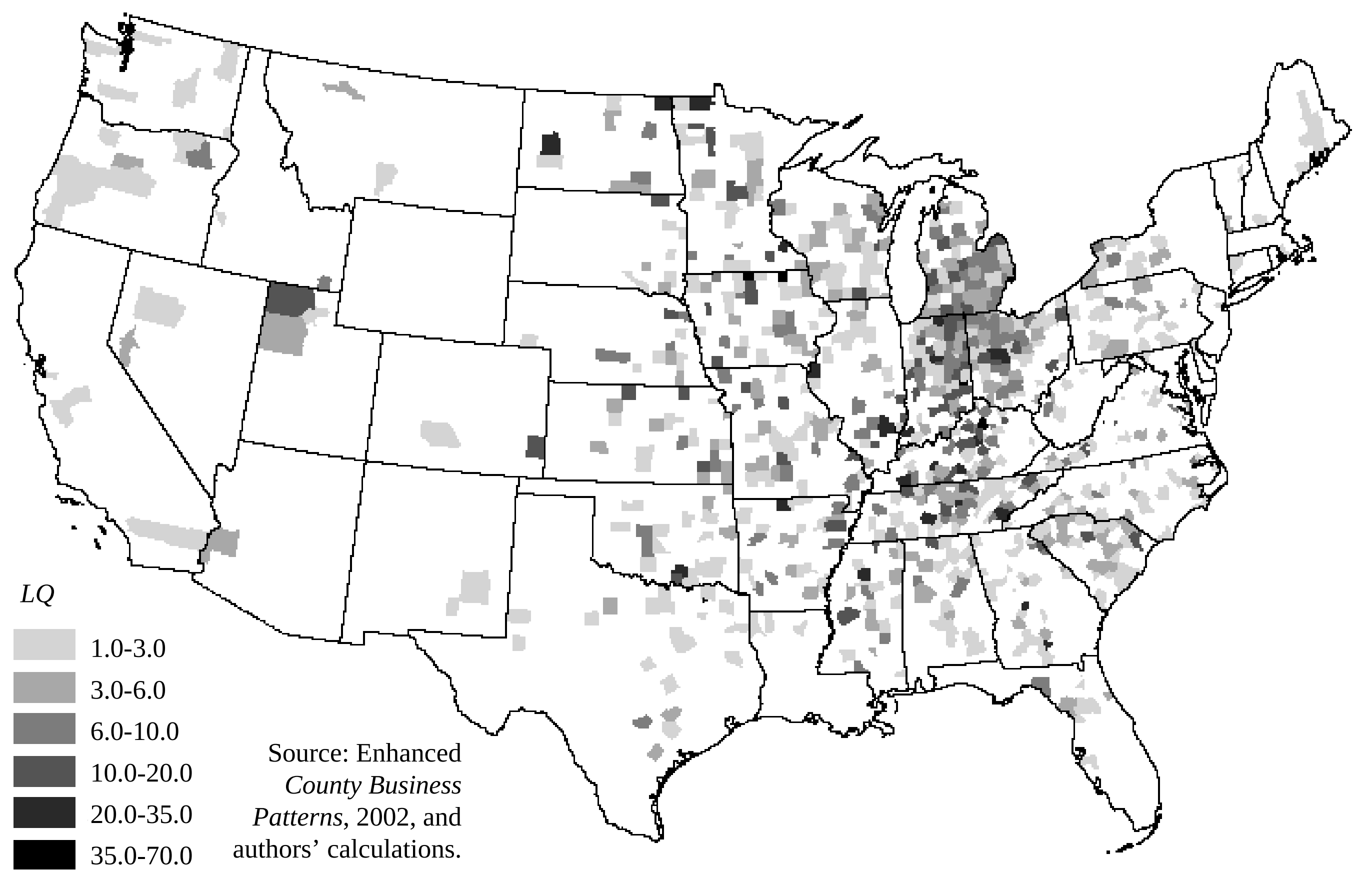
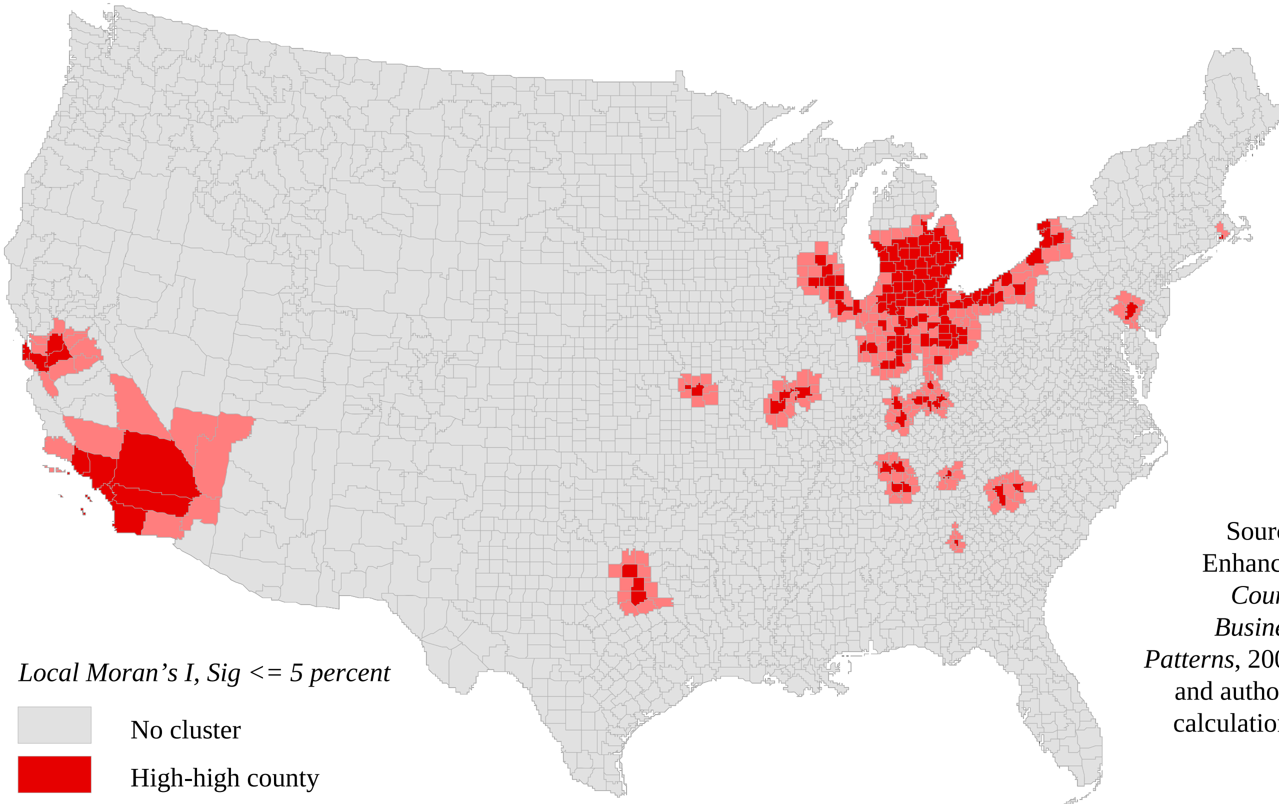


Figure 4. Employment location quotients by county, motor vehicle value chain



Local Moran's I, Sig <= 5 percent

No cluster

High-high county

Adjacent county

Source: Enhanced *County Business Patterns*, 2002, and authors' calculations.

Figure 5. Significant motor vehicles value chain employment clustering

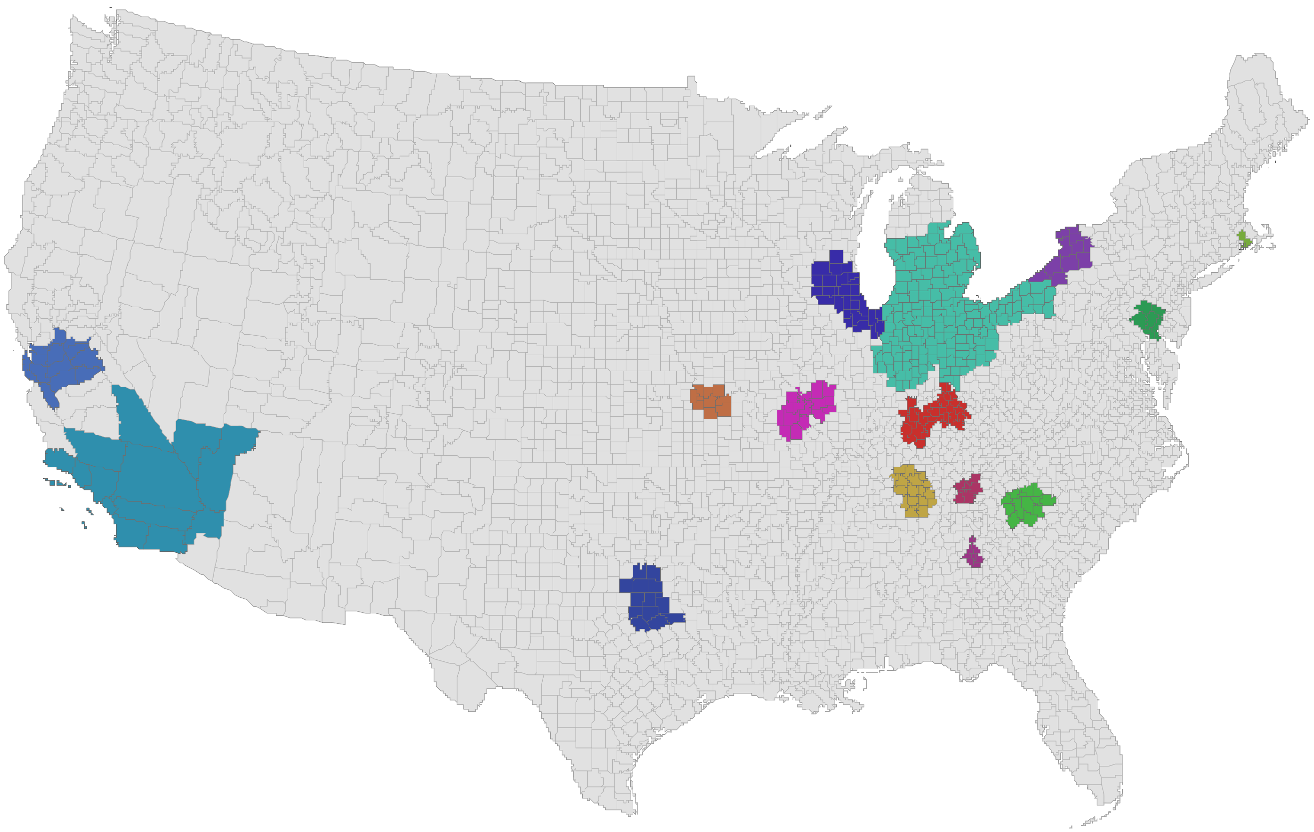


Figure 6. Fifteen identified motor vehicles value chain clusters

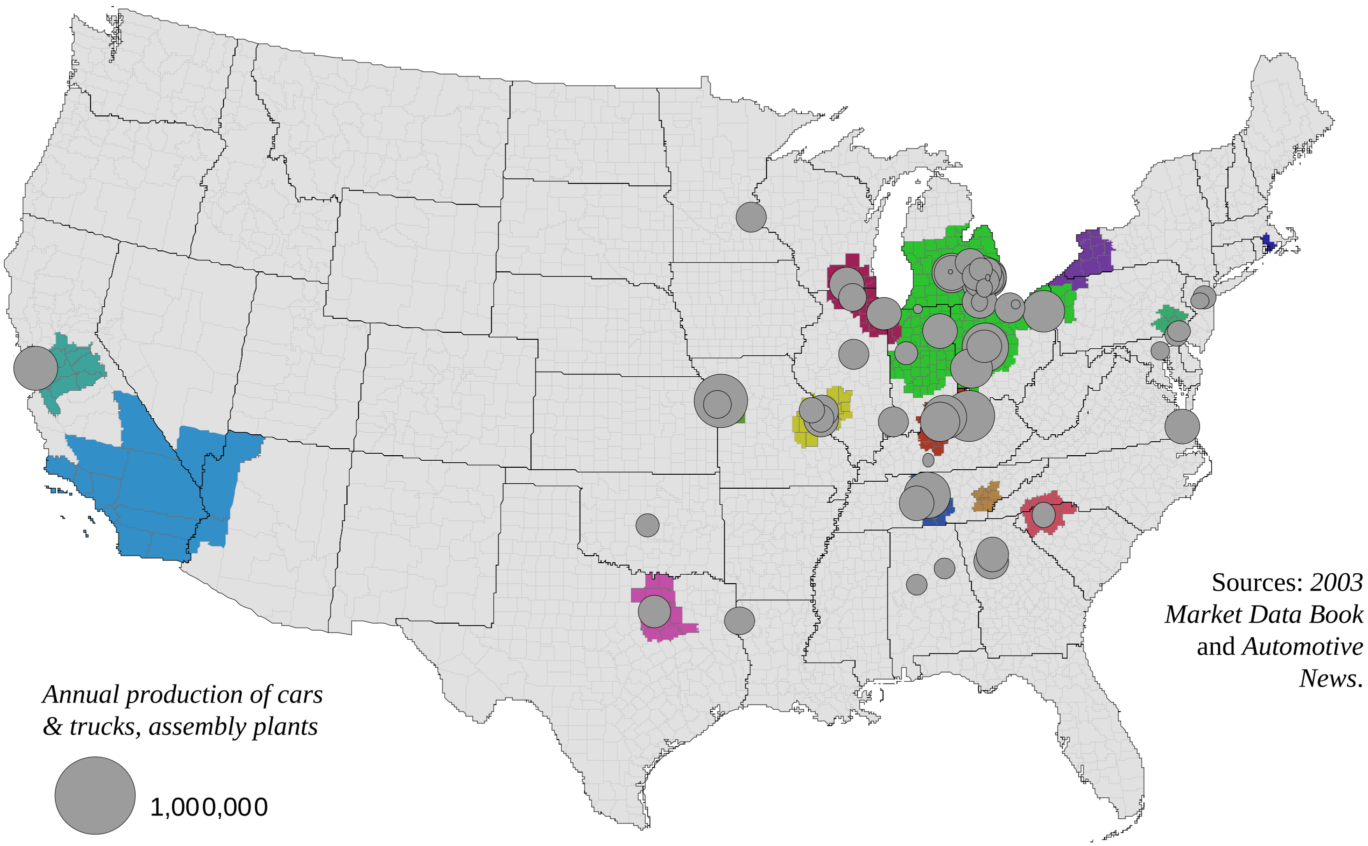


Figure 7. Vehicle unit production, 2003