Revisiting Industry Cluster Theory and Method For Use in Public Policy: An Example Identifying Supplier-Based Clusters in Missouri.

David J. Peters
Office of Social and Economic Data Analysis, University of Missouri, Columbia, MO 65211-4260.
E-mail: PetersDJ@missouri.edu

ABSTRACT. Industry cluster theory and method is synthesized to present a conceptually clear cluster blueprint for use in economic development public policy. Theoretically, the blueprint defines industry clusters as a group of economically competitive industries that are interdependent because of shared resources. Methodologically, the blueprint identifies competitive industries using cluster and discriminant function analyses, and then identifies commonalities among the competitive industries along a single resource using factor analysis. Using the blueprint, nine supplier-based clusters in Missouri were identified. The blueprint is being used for economic development planning and policy to support the Missouri Automotive Partnership.

AUTHOR'S CONTACT: Direct all correspondence to David J. Peters, Office of Social and Economic Data Analysis, 602 Clark Hall, University of Missouri, Columbia, MO 65211-4260. Telephone: 573-882-7396. Fax: 573-884-4635. E-mail: PetersDJ@missouri.edu

1. INTRODUCTION

The concept of industry clusters has generated much attention during the last decade, yet any definition of what constitutes an industry cluster is obscure since it encompasses many divergent theoretical and methodological approaches (Best, 1990; Fagan, 2000). Industry clusters is a multidimensional concept grounded by a range of economic theories and measured using a variety of methodological approaches. Theoretically, the concept of industrial clustering is grounded in well established economic theory, especially external economy and agglomeration theory (Hoover, 1937; Marshall, 1890; Perroux, 1950). Methodologically, clusters are identified using both qualitative and quantitative data and methods (Austrian, 2000). Feser (1998b) notes that the diversity of cluster theory and method has created widespread confusion on what clusters are, how they differ from other agglomeration concepts, and how best to identify them. Theoretically this diversity is one of the concept's strengths. However, pragmatically this diversity hinders the concept's utilization in public policy.

Therefore, industry cluster theory and method needs to be revisited and clarified if the concept is to be useful in economic development theory and praxis. Towards that end, this article presents a conceptual blueprint for both defining and identifying industry clusters. Based on previous theory and method, the blueprint defines industry clusters as being composed of economically competitive industries that are interdependent because of shared commonalties along some resource, such as suppliers, customers, labor or technology. Within any set of competitive industries there exists several cluster groupings depending on the resource criterion.

The cluster blueprint can affect economic development policy by providing a well conceptualized and empirically based definition of what constitutes an industry cluster.

When clusters are defined using political rather than empirical justifications, development agencies run the risk of investing scare resources into groups of industries that will produce little to no economic benefits (Held, 1996; Waits, 2000). By basing economic development strategies on competitive clusters, public resources can be directed towards the most viable parts of the economy. In short, an empirically justified definition is essential if economic development officials are to craft policies aimed at developing industry clusters.

2. INDUSTRY CLUSTER THEORY AND METHOD

Given the varied theoretical perspectives regarding industry clusters, it is important to delineate the characteristics of clusters that are agreed upon in the literature. Steiner (1998) asserts that that there are key features common to all theories of industry clusters. First, clusters are based on specialization that results from a high division of labor within the economy. This naturally leads to a high degree of interdependence among economic actors, which leads to increased cooperation. This cooperation can take the form of inter-industry transactions between firms, knowledge exchanges between individuals and institutions, or linkages between public and semi-public institutions (Best, 1990). These linkages can be based on either formal contracts or social, cultural and political ties. Second, specialization and interdependence is partly based on proximity in both economic and social space (Martin & Sunley, 1996; Oakey, Kipling & Wildgust, 2001). Proximity in economic space entails firms producing similar goods or services. Proximity in social space entails firms sharing similar cultural, political and normative traits.

This combination of specialization and proximity results in synergies that increase the competitiveness of the region, which results in higher productivity, stabilization and wealth creation for both the firm and region (Baptista & Swann, 1998; Baptista & Swann, 1999; Hall & Markusen, 1985). Even within the context of a globalized economy geographic space is still important. Lublinski (2003) and Saxenian (1996) talk of a location paradox, where economic activity still tends to be spatially concentrated even though improved information technologies and changes in the economy have made the transmission of financial capital, knowledge and certain goods and services unconstrained by geography.

Perhaps one of the most well known theorists of industry clusters is Michael Porter (1990; 2000). He argues that clusters consist of a geographic concentration of competitive firms in related industries that have a competitive advantage because they share certain components. Using success in international markets as an indicator of national competitiveness, Porter delineated four components of his concept of locational competitive advantage that affects firm competitiveness and regional wealth. First, firm competitiveness was affected by attitudes towards competition, the degree of local competition, attitudes towards market institutions and other socio-historical factors – termed the context for firm strategy and rivalry condition. Second, firm competitiveness was affected by the basic resource endowments available within a geographic area, such as the quantity, quality and cost of natural, human, capital, information and technological resources – termed the factor or input condition. Third, firm competitiveness was affected by the nature of local and extra-local demand for domestic and foreign goods for industry or household consumption – termed the demand condition. Fourth, firm competitiveness was affected by the presence of related and supporting industries, where competition among local intermediate suppliers resulted in lower prices – termed the related and supporting industries condition.

Despite all of the advantages imputed to industry clusters there are some dangers in developing them. One disadvantage is that areas dependent on clusters are more vulnerable to changes in the economy that may result in long-term economic decline or short-term economic instability (Feser, 1998a; Feser, 1998b; Harrison, 1992; Kaufman, Gitell, Merenda, Naumes, & Wood, 1994; McMichael, 1996; Rosenfeld, 1997; Tichy, 1998). Another disadvantage is that clusters naturally benefit some regions over others, where periphery regions may be adversely affected by strong growth in core regions (Ellison & Glaeser, 1997; Henderson, 1986; Henderson, 1997; Jaffe, Trajtenberg, & Henderson, 1993; Kim, Barkley & Henry, 2000). This presents a conundrum for development agencies in crafting cluster policies, since they are often mandated to decrease geographic disparities in employment and income. In essence, cluster policies may concentrate economic prosperity in a few select places, so that a region uses advantage to beget advantage.

From a policy perspective, another disadvantage is that cluster initiatives are prone to failure because they are often poorly conceptualized and developed (Held, 1996; Waits, 2000). This is caused by the fact that clusters are often defined using political justifications rather than economic justifications. When cluster policy is not based on sound economic rationale and rigorous methods, development agencies run the risk of investing scare resources into a few industries that will produce no economic benefit. This point is even more important when coupled with the opportunity costs of investing those resources in basic infrastructure that benefits all industries.

Despite these shortcomings, the concept of industry clusters is useful in economic development theory and praxis. Paraphrasing Feser (1998b) and Tichy (1998), although industry clusters are not generally considered a new model of regional development, the concept is useful in delineating how economic and geographic interdependencies are integral to regional development. However, the authors caution that failure to base cluster policies on sound theory and empirical evidence increases the risks of ineffectual policy and wasted resources. The cluster blueprint presented in this article shares Feser's and Tichy's optimisms and concerns.

3. SYNTHESIS OF THEORY AND METHOD – CLUSTER BLUEPRINT

As stated above, for cluster-based public policies to succeed it is critical that they be grounded on economic theory and empirical data. By synthesizing previous theory and method, a conceptual cluster blueprint was developed that both theoretically defines and methodologically identifies industry clusters for use in economic development public policy. The blueprint assumes that industry clusters are composed of economically competitive industries that are interdependent because they share resources. Within any set of competitive industries there exists several cluster groupings, depending on the resource criterion of interest. For example, supplier-based clusters are industries with shared interdependence on backward linkages or buy transactions. Customer-based clusters are industries with shared interdependence on forward linkages or sell transactions. Labor-based clusters are industries with shared interdependence on occupational or labor needs. Lastly, technology-based clusters are industries with shared interdependence on technology or innovations. The concept is presented graphically in Figure 1.

Why focus on competitiveness? Theoretically, industry clusters consist of a geographic concentration of competitive industries that possess commonalties that give them a competitive advantage over the same industries in other areas (Hill & Brennan, 2000; Porter, 1990; 2000). Competitiveness is a necessary precondition for a group of industries that share commonalties to be termed a cluster. Otherwise, a group of industries that share commonalties but are not competitive are termed industry complexes (Hill & Brennan, 2000). In short, competitiveness and commonality are at the heart of this strand of cluster theory, to use current economic advantage to beget future economic advantage.

Methodologically, the blueprint empirically defines clusters in two stages. In the first stage, competitive industries within an economy are identified using cluster and discriminant function analyses. These techniques identify groups of mutually exclusive industries that are similar in terms of their economic competitiveness within the economy. In the second stage, the degree of interdependence or commonality among the competitive industries along some resource is assessed using factor analysis. This technique identifies groups of competitive industries that are highly correlated along some resource criterion.

There are several policy advantages associated with using the cluster blueprint. First, the blueprint provides a theoretical framework for conceptualizing industry clusters, with its assumptions that clusters are composed of economically competitive industries that are interdependent because of shared commonalties along some resource. Second, the blueprint provides a methodological framework for empirically defining the industry cluster concept by using cluster and discriminant function analyses to identify competitive industries, and factor analysis to identify commonalties along some resource criterion. Third, the blueprint argues that clusters are best delineated along a single shared resource, rather than multiple ones. Defining clusters along multiple shared resources is methodologically complex and more conceptually difficult to understand, especially by policy officials. By defining clusters using a single shared resource, policy officials are better able to understand the linkages among that particular resource and the competitive industries within the economy.

Figure 1 About Here

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4. IDENTIFYING COMPETITIVE INDUSTRIES

To identify Missouri's competitive industries, a mathematical cluster analysis was used to group industries based on how economically competitive they were relative to the national average. Once grouped, multivariate analysis of variance and discriminant function analysis were used to identify unique characteristics of the clusters and to assess the internal validity of the groupings. Use of cluster and discriminant analyses follows the work of Hill and Brennan (2000), who utilized these methods to identify drivers of regional economies.

Data in this analysis was taken from the Minnesota IMPLAN Group who compiled cross-sectional data to construct a comprehensive and accurate database at the county-level with a consistent structure (MIG, 1999). Since the data is disaggregated by county, the analysis can be replicated for any combination of counties to approximate economic regions. Nine variables were used to measure the economic competitiveness of a single industry in Missouri relative to the national average for that industry between 1997 and 2000.

Economic specialization for an industry in Missouri was measured by calculating location quotients for output, employment, compensation and foreign exports in 2000. The formula for a location quotient is given in Equation (1), where X is the economic variable of interest, i is the industry, r the region and n the nation.

(1) $$LQX_{ir} = (X_{ir}/X_r)/(X_{in}/X_n)$$

Economic growth for an industry in Missouri was measured by calculating the difference in growth rates between Missouri and the United States, which was done for output, employment, compensation and foreign exports between 1997 and 2000. The formula used to calculate the difference in growth rates is given in Equation (2), where X is the economic variable of interest, i is the industry, r the region, n the nation and t is time period.

(2) $$\Delta X_{ir} = \left(\left(\left(X_{ir}^{t} - X_{ir}^{t-1}\right) / X_{ir}^{t-1}\right) * 100\right) - \left(\left(\left(X_{in}^{t} - X_{in}^{t-1}\right) / X_{in}^{t-1}\right) * 100\right)$$

Economic productivity for an industry in Missouri was measured by calculating the ratio of output per worker between Missouri and the United States in 2000. The formula used to calculate the productivity measure is given in Equation (3), where O is output, E is employment, i is the industry, r the region and n the nation.

(3) $$PROD_{ir} = \left(O_{ir} / E_{ir}\right) / \left(O_{in} / E_{in}\right)$$

Cluster analysis is the generic name for a wide variety of procedures that can be used to create a classification. These procedures start with data containing information about a sample of entities and attempts to mathematically reorganize these entities into relatively homogenous groups. Cluster analysis was used to group 509 industries (rows) according to their similarity along nine economic competitiveness variables (columns). Industries were combined into clusters based on a distance matrix between all possible pairs of industries (Aldenderfer & Blashfield, 1984). Squared Euclidean distance was used to measure the distance between clusters and industries. Ward's cluster method (Ward, 1963) was used to group industries into clusters, and worked by joining those industries that resulted in the minimum increase in the variance or error sum of squares

(ESS). Ward's method tended to create clusters of relative equal sizes and shapes as hyperspheres.

According to Aldenderfer and Blashfield (1984), the three main criteria for determining an appropriate cluster solution include fusion coefficients, Mojena's Stopping Rule and dendograms. Determination of the appropriate number of clusters is difficult since no single agreed upon methodology exists, so cluster determination is partly a subjective process (Everitt, 1979). The results of the cluster analysis, presented in Table 1, indicated the presence of 13 clusters.

Fusion coefficients are an index of the loss of information incurred when merging two clusters. A large loss of information is indicated by a jump in the fusion coefficients. This jump implies that two relatively dissimilar clusters have been merged, thus the number of clusters prior to the merger is the most probable cluster solution (Aldenderfer & Blashfield, 1984). There was a significant loss of information at stage 498, and taking the prior cluster stage this indicated a 12-cluster solution.

Mojena's Stopping Rule is a method whereby a significant jump in the fusion coefficients can be better defined (Milligan & Cooper, 1985; Mojena, 1977). The procedure is based on the mean and standard deviation of all fusion coefficients. The Mojena value exceeded the fusion coefficient at stage 495, and taking the prior cluster stage this indicated a 15-cluster solution.

Dendograms are mainly heuristic devices that provide an important validation of the cluster solution. Dendograms permit the researcher to see where cases and clusters merged together to get a better understanding of the underlying structure of the data. Examination of the dendogram indicated the presence of 13 to 14 clusters.

Lastly, the cluster solution using Ward's method and squared Euclidean distance was compared to other solutions using alternative methods. These included the average within-groups linkage method using squared Euclidean distance, and the centroid method using squared Euclidean distance. All three methods yielded highly similar cluster solutions, indicating that there was inherent structure in the data.

Table 1 About Here

Once industries were grouped using cluster analysis, the solution was statistically validated using multivariate analysis of variance (MANOVA) and discriminant function analysis (DFA). Results of the MANOVA found that the mean differences across all economic competitiveness variables were significantly different from each other across the 13 clusters, using the Pillais Criterion ($F_{(108,4464)}$=32.91, p<0.000), Hotellings Trace Criterion ($F_{(108,4376)}$=506.82, p<0.000) and Wilks Lamba ($F_{(108,3565)}$=126.82, p<0.000) statistics. Univariate F-tests showed that the nine economic competitiveness variables were significantly different between all 13 clusters at $p > 0.000$.

Discriminant function analysis (DFA) is chiefly used to predict group membership from a set of predictors, and identifies the linear combination of variables that drive the classification process (Tabachnick & Fidell, 1996). The resulting discriminant functions were interpreted like regression coefficients to assess the degree of strength and direction the function exerted on classification. This permitted the researcher to more closely examine the meaning of the clusters from the data, rather than subjectively labeling clusters by industry names. Table 2 presents the six discriminant functions that drove the classification process, which correctly classified 93.9% of all industries into the 13 groups derived from the cluster analysis.

Six clusters were identified as competitive based on economic specialization relative to the national average, which is presented in Tables 2 and 3. This resulted in 82 competitive industries where Missouri had a competitive advantage relative to the national economy. Industries classified into the competitive fast growth cluster and the competitive slow growth cluster were highly specialized in output, employment, compensation and foreign exports relative to the national average (function 2). Industries classified into the emerging hyper growth cluster had foreign exports that were growing faster than the national average (function 1). Industries classified into the emerging fast growth cluster had output, employment and compensation that were growing faster than the national average and whose productivity per worker was below the national average (function 3). Industries classified into the emerging moderate growth cluster and the emerging slow growth cluster were highly specialized in output, employment, compensation and foreign exports relative to the national average (function 2).

Table 2 About Here

Table 3 About Here

The 82 competitive industries had a sizable impact on Missouri's economy, accounting for 42.8% of total foreign exports, 17.7% of total output, 10.0% of total compensation and 8.3% of total employment. In addition, these driver industries paid an average annual wage per job of $34,653, which was moderately more that the state average wage per job. In terms of output per worker, productivity was highest in the emerging hyper growth cluster ($37,402 per worker) and lowest in the emerging fast growth cluster ($14,349 per worker). In terms of wages per job, the highest paying jobs were in the competitive fast growth cluster ($72,795 per job) and lowest paying were in the emerging slow growth cluster ($30,086 per job). In terms of foreign exports per worker, the hyper growth cluster was the most export intensive ($76,085 per worker) and the emerging fast growth cluster was the least intensive ($6,486 per worker). A complete list of the competitive industries is presented in the appendix.

5. IDENTIFYING SUPPLIER-BASED CLUSTERS

To identify Missouri's supplier-based industry clusters, factor analysis was used to group the 82 competitive industries according to their similarity of supplier purchases along 509 commodities in Missouri. The resulting factors or clusters are groups of competitive industries with shared interdependence on backward linkages or buy transactions occurring within Missouri. Backward linkages, buy transactions and supplier purchases are used interchangeably to refer to commodities purchased by the competitive industries for use in their production processes.

Data on supplier purchases in Missouri was taken from the use matrix derived by the Minnesota IMPLAN Group for Missouri in 2000. The use matrix details the dollar value of Missouri goods and services purchased by each competitive industry for use in their production processes. It is important to note that the Missouri use matrix only included the purchases of Missouri commodities by Missouri's competitive industries, and does not include the purchases of commodities made outside of Missouri (i.e. imported from elsewhere in the United States or the world). The use matrix consisted of 509 Missouri commodities (rows) purchased as a percentage of all commodities purchased for each of the 82 Missouri competitive industries (columns).

Factor analysis is a statistical technique that was used to identify coherent subsets of competitive industries that were highly correlated with one another in terms of their supplier purchases, but were largely independent of other subsets of competitive industries. The factors identified using this technique are thought to reflect the underlying processes that account for the correlations among the competitive industries. Therefore, the utility of this technique was in summarizing the correlations among the competitive industries in terms of their supplier purchases.

However, there are several disadvantages associated with using factor analysis, as outlined by Tabachnick and Fidell (1996). First, in factor analysis there is no criterion variable in which to test the factor solution as there is in other multivariate procedures like regression. Second, there are a multitude of factor solutions that can be obtained using different extraction and rotation techniques that account for the same amount of variance, but where the factors are slightly different. Because of these two critiques, there is a perception among some researchers that factor analysis is a questionable statistical procedure that produces subjective and hard to replicate findings. When done correctly, however, factor analysis is useful in identifying patterns of correlations within data that seemingly have no order.

Although factor analysis places few assumptions on the data, several issues were addressed to enhance the factor solution, as outlined by Loehlin (1992). First, initial screening found the competitive industry variables to be non-normally distributed, being moderately leptokurtic and positively skewed. To correct for this, the variables were transformed to their square root to approximate normality. Second, seven competitive industries were identified as outliers and were removed from the data. Lastly, the data was deemed factorable since correlations between all variables was above r=0.60, and the Kaiser-Meyer-Olkin Measures of Sampling Adequacy were above KMO=0.70 for all factor solutions.

Two main types of techniques were used in extracting factors. Principal components analysis (PCA) analyzed all the variance among the competitive industries, including unique and error variance. By contrast, principal factors analysis (PFA) analyzed the covariance or shared variance among the competitive industries, excluding unique and error variance. Once the solutions had been extracted, the factors were rotated to improve the interpretability and utility of the solution without changing their underlying mathematical properties. Orthogonal rotation techniques were used when the factors were uncorrelated with each other. Oblique rotation techniques were used when the factors were correlated with each other.

Both PCA and PFA were used as extraction techniques and both produced similar results, indicating inherent structure in the data. Since the main objective of this analysis is to understand the relationships between the competitive industries in terms of their supplier purchases (i.e. understanding total variance), only the results of the PCA were reported. Results of the interfactor correlation matrix found that 80.6% of the correlations were above r=0.30, indicating that an oblique rotation was warranted (Loehlin, 1992).

The final factor solution reported here, using principal components analysis and oblique rotation, was deemed adequate according to tests developed in the literature that seek to strike a balance between having enough factors to explain the variance without losing parsimony (Kim & Mueller, 1978; Loehlin, 1992; Tabachnick & Fidell, 1996). First, the number of factors and the variance explained was approximated using eigenvalues, which measure the variance accounted for by a given dimension or factor. The solution extracted nine factors with eigenvalues over 1.0, which accounted for 81.08% of total variance in the data (refer to Table 4). Second, the adequacy of the solution was determined by looking for large values in the residual correlation matrix, which is the difference between the reproduced and observed correlation matrices. The solution was deemed adequate since only five percent of the residual correlations exceeded 0.05, which indicates the factor solution adequately reproduced the original correlation matrix.

Relationships between the competitive industries were interpreted from the pattern matrix, which is a set of unique relationships between each factor and each competitive industry that is uncontaminated by overlap among factors. Higher factor loading scores indicated a higher correlation between the factor and the competitive industry. Loehlin (1992) and Tabachnick and Fidell (1996) suggest items in the pattern matrix should only be interpreted if the loadings are sufficiently high (0.475 or more) and do not crossload with other items (±0.15 difference). However, crossloadings were interpreting since the main objective of the analysis is to understand the correlations between industries and factors. Crossloadings indicate that the competitive industry is highly correlated with more than one factor, indicating shared suppliers across clusters. The automatic merchandising machines industry (SR345) crossloaded on factors 7 and 1; the grass seeds industry (SR14) crossloaded on factors 8 and 3; and the glass containers industry (SR231) crossloaded on factors 8 and 5. The pattern matrix is presented in Table 4. Industry identifiers in the pattern matrix are described in the appendix.

Table 4 About Here

In summary, the results of the factor analysis identified nine supplier-based industry clusters, which were coherent sets or factors of competitive industries that were highly correlated in terms of their Missouri suppliers, but were independent of other sets of competitive industries – save for crossloadings. The factors were labeled according to the highest loading competitive industries, taken from the pattern matrix. The competitive industries that comprise the supplier-based industry clusters are listed in Table 5 and include: precision products (factor 1), leather products (factor 2), livestock (factor 3), food grain products (factor 4), stone and clay products (factor 5), wood products (factor 6), motorized products (factor 7), container products (factor 8), and food dairy products (factor 9).

Table 5 About Here

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6. DISCUSSION AND CONCLUSION

By clarifying industry cluster theory and method, supplier-based clusters can be effectively utilized in economic development planning and policy. In terms of economic development planning, this analysis provides a conceptual and empirical basis for understanding industry clusters centered around supply chains and its linkages within the economy. It provides an empirical definition of supplier-based clusters by identifying groups of competitive industries that are highly correlated in terms of their Missouri suppliers. It provides information on the top Missouri commodities purchased by each supplier-based cluster. Lastly, it provides current economic and labor market information on the supplier-based clusters.

In terms of economic development policy, the Missouri Department of Economic Development is utilizing this analysis to provide a conceptual and empirical basis for linking particular public and private entities in Missouri based on supply chains. By identifying both clusters of competitive industries that share suppliers and the top commodities purchased by each cluster, economic development officials can link specialized state agencies, cluster firms and supplier firms in order to maintain, improve and expand a particular supply chain in Missouri. This has potential benefits for both government and business in Missouri.

For state government, strengthening the Missouri supply chain for a particular cluster will likely increase the indirect economic impact of that cluster within the state, which would increase overall economic activity and tax revenues. Indirect economic activity is generated through the cluster's purchases of goods and services from other industries for use in their production process. These goods and serviced can either be acquired locally from Missouri producers or imported from elsewhere outside the state. The more these goods and services are acquired locally from Missouri producers the greater the indirect economic activity in the state.

For business, linking state agencies, cluster firms and supplier firms provides a forum in which to discuss important issues related to the supply chain, and to plan steps to address these issues. For example, a supplier-chain forum would permit cluster firms to discuss strategies for acquiring specific inputs more cheaply, preferably from local suppliers. It would permit supplier firms to discuss how best to meet the demands of their customers, who in part are the cluster firms who buy their goods and services. It would permit both cluster and supplier firms to discuss issues and plan solutions for improved transactions in the supply chain, such as planning for improved products or changing technology. Lastly, it would permit government agencies to discuss with businesses how best to target public resources to address issues identified by the cluster and supplier firms.

The Missouri Department of Economic Development is currently using the information from this analysis to support the Missouri Automotive Partnership (MAP).

Created by executive order by Missouri Governor Bob Holden, MAP's purpose is to provide research and information for the promotion of the automotive industry; and to strengthen collaboration between industry, labor organizations, state government and higher education institutions. The partnership has 36 members representing automotive assemblers, automotive suppliers, organized labor, universities, community colleges, state economic development and labor officials, legislators and regional economic developers. One goal of MAP is to strengthen the Missouri supply chain for the automotive industry, which was identified as part of the motorized products supplier-based cluster. The information derived from this analysis is being used by MAP in economic development planning and policy to support this cluster in Missouri.

In terms of planning, MAP officials are using this information to identify similar competitive industries in the motorized products cluster, to identify the top suppliers of this cluster, and to determine the economic impact of this cluster in the state. The motorized products cluster consists of eight competitive industries that are highly correlated in terms of their Missouri suppliers. Listed in Table 5, these industries include internal combustion engines not elsewhere classified, refrigeration and heating equipment, motors and generators, motor vehicles, truck trailers, boat building and repair, and motorcycles and bicycles. In addition, the automatic merchandising machines industry shared suppliers with the motorized products cluster and the precision products cluster.

On average, the motorized products cluster purchases 41.8 percent of its total supplies from Missouri producers. For purchases made within the state, there is a high degree of supplier purchases from other firms within the motorized products cluster. Listed in Table 6, the top Missouri commodities purchased by the motorized products cluster for use in their production processes includes wholesale trade, internal combustion engines not elsewhere classified, refrigeration and heating equipment, motor freight transportation and warehousing, motor vehicle parts and accessories, motors and generators, and banking.

The motorized products cluster also accounts for a significant amount of economic activity in Missouri's overall economy (refer to Table 7). The cluster employs 42,146 workers and pays \$2.678 billion in compensation. On average, the cluster pays an average wage of \$63,152 per job, which is 211 percent of the state average wage per job. Additionally, in Missouri this cluster accounts for 12.57 percent or \$2.585 billion of total foreign exports, 4.96 percent or \$16.396 billion of total output, 2.54 percent or \$2.678 billion of total compensation, and 1.20 percent or 42,146 of total employment.

In terms of policy, MAP officials are using this information to guide efforts at creating a motorized products supply-chain forum, which would link state agencies, motorized products firms and their supplier firms. The forum being developed by MAP would include representatives from the three groups mentioned above, who would meet regularly to discuss issues related to the motorized products supply chain. MAP officials envision the forum as a means to identify issues associated with the motorized products supply chain and to marshal resources to address those issues, as demonstrated in the following hypothetical example.

Assume that a motorized products supply-chain forum was created in Missouri, and that at one of the meetings representatives from the motor vehicles industry expressed concerns about the quality of engines and motors purchased from their Missouri suppliers. Further assume that the forum agreed that the solution to this problem was to have several of the Missouri supplier firms become certified by the

International Standards Organization (ISO). ISO certification specifies requirements for a quality management system for any organization that needs to demonstrate its ability to consistently provide products that meets customer and applicable regulatory requirements, and also aims to enhance customer satisfaction.

In this example, both business and government would collaborate to implement the solution identified in the forum, with each incurring costs as well as deriving benefits. Supplier firms in the internal combustion engines not elsewhere classified and the motors and generators industries would agree to expend resources obtaining ISO certification; and in return the firms would secure continued sales from the motor vehicles industry, and very likely expand sales elsewhere due to certification. Cluster firms in the motor vehicles industry would agree to continue purchasing engines and motors from their Missouri suppliers; and in return the firms would obtain better quality products that meet their specific industry needs and standards. In addition, other firms in the motorized products cluster, such as boat and motorcycle manufacturers, would also benefit from better quality engines and motors. Lastly, government agencies would agree to provide financial and technical assistance to the supplier firms enabling them to obtain ISO certification; and in return the state would have a stronger motorized products cluster, which would increase the likelihood of the cluster and its suppliers expanding and generating tax revenues.

Table 6 About Here

Table 7 About Here

In conclusion, this article synthesized industry cluster theory and method into a conceptually clear cluster blueprint for use in economic development public policy. By using the blueprint, cluster policies can be crafted based on sound economic theory and rigorous methods. First, it provides a theoretical framework for conceptualizing industry clusters, with its assumptions that clusters are composed of economically competitive industries that are interdependent because of shared commonalties along some resource. Second, it provides a methodological framework for empirically defining the industry cluster concept by using cluster and discriminant function analyses to identify competitive industries, and factor analysis to identify commonalties along some resource criterion. Third, it provides a way to delineate commonalities along a single resource, rather than multiple resources, in order to better understand linkages within the economy and in order to develop resource-specific policies. In short, by identifying clusters using empirical rather than political justifications, economic development officials can direct programs and funding towards specific supplier resource needs in the most competitive parts of their economy.

REFERENCES

Aldenderfer, M. & Blashfield, R. (1984). *Cluster Analysis*. Sage University Paper Series on Quantitative Applications in the Social Sciences, Series Number 07-044. London: Sage Publications.

Austrian, Z. (2000). Cluster Case Studies: The Marriage of Quantitative and Qualitative Information for Action. *Economic Development Quarterly*, 14, 65-96.

Baptista, R. & Swann, G.M.P. (1998). Do Firms Cluster to Innovate More? *Research Policy*, 27, 525-540.

Baptista, R. & Swann, G.M.P. (1999). The Dynamics of Firm Growth and entry in Industrial Clusters: A Comparison of the US and UK Computer Industries. *Journal of Evolutionary Economics*, 9, 373-399.

Best, M. (1990). *The New Competition: Institutions of Industrial Restructuring*. Cambridge: Polity Press.

Ellison, G. & Glaeser, E.L. (1997). Geographic Concentration in U.S. Manufacturing Industries: A Dartboard Approach. *Journal of Political Economy*, 105, 889-927.

Everitt, B. (1979). Unresolved Problems in Cluster Analysis. *Biometrics*, 35, 169-184.

Fagan, J.H. (2000). Do Northeast Ohio's Drivers Derive Competitive Advantage from Shared Labor? *Economic Development Quarterly*, 14, 65-96.

Feser, E. (1998a). Enterprises, External Economies and Economic Development. *Journal of Planning Literature*, 12, 283-302.

Feser, E. (1998b). Old and New Theories of Industry Clusters. In M. Steiner (Eds.), *Clusters and Regional Specialisation* (pp.18-40). London: Pion Limited.

Hall, P. & Markusen, A. (1985). *Silicon Landscapes*. Boston: Allen & Unwin.

Harrison, B. (1992). Industrial Districts: Old Wine in New Bottles? *Regional Studies*, 26, 469-483.

Harrison, B., Kelly, E. & Gant, J. (1996). Innovative Firm Behavior and Local Milieu: Exploring the Intersection of Agglomeration, Firm Effects, Industrial Organization and Technological Change. *Economic Geography*, 72, 233-258.

Held, J.R. (1996). Clusters as an Economic Development Tool: Beyond the Pitfalls. *Economic Development Quarterly*, 10, 249-261.

Henderson, J.V. (1986). Efficiency of Resource Usage and City Size. *Journal of Urban Economics*, 19, 47-70.

Henderson, J.V. (1997). Externalities and Industrial Development. *Journal of Urban Economics*, 42, 449-470.

Hill, E.W. & Brennan, J.F. (2000). A Methodology for Identifying the Drivers of Industrial Clusters: The Foundation for Regional Competitive Advantage. *Economic Development Quarterly*, 14, 65-96.

Hoover, E.M. (1937). *Location Theory and the Shoe and Leather Industry*. Cambridge: Harvard University Press.

Jaffe, A.B., Trajtenberg, M., & Henderson, R. (1993). Geographic Localization of Knowledge Spillovers as Evidenced by Patent Citations. *Quarterly Journal of Economics*, 108, 577-598.

Kaufman, A., Gitell, R., Merenda, M., Naumes, W., & Wood, C. (1994). Porter's Model for Geographic Competitive Advantage: The Case of New Hampshire. *Economic Development Quarterly*, 8, 43-66.

Kim, Y., Barkley, D.L., & Henry, M.S. (2000). Industry Characteristics Linked to Establishment Concentrations in Nonmetropolitan Areas. *Journal of Regional Science*, 40, 231-259.

Kim, J-O & Mueller, C.W. (1978). *Factor Analysis: Statistical Methods and Practical Issues*. Sage University Paper Series on Quantitative Applications in the Social Sciences, Series Number 07-014. London: Sage Publications.

Loehlin, J.C. (1992). *Latent Variable Models: An Introduction to Factor, Path and Structural Analysis*. London: Lawrence Erlbaum Associates.

Lublinski, A.E. (2003). Does Geographic Proximity Matter? Evidence from Clustered and Non-Clustered Aeronautic Firms in Germany. *Regional Studies*, 37, 453-467.

Marshall, A. (1890). *Principles of Economics: An Introductory Volume*. 9th Edition published in 1961. London: Macmillan.

Martin, R. & Sunley, P. (1996). Paul Krugman's Geographical Economics and Its Implications for Regional Development Theory: A Critical Assessment. *Economic Geography*, 72, 259-292.

McMichael, P. (1996). *Development and Social Change: A Global Perspective*. Thousand Oaks: Pine Forge Press.

Milligan, G.W. & Cooper, M.C. (1985). An Examination of Procedures for Detecting the Number of Clusters in a Dataset. *Psychometrika*, 50, 159-179.

Minnesota IMPLAN Group. (1999). *IMPLAN Pro Technical Manual*. Stillwater MN: MIG.

Mojena, R. (1977). Hierarchical Grouping Methods and Stopping Rules - An Evaluation. *Computer Journal*, 20, 359-363.

Oakey, R., Kipling, M., & Wildgust, S. (2001). Clustering Among Firms in the Non-Broadcast Visual Communications (NBVC) Sector. *Regional Studies*, 35, 401-414.

Perroux, F. (1950). Economic Space: Theory and Applications. *Quarterly Journal of Economics*, 64, 89-104.

Porter, M.E. (1990). *The Competitive Advantage of Nations*. New York: Free Press.

Porter, M.E. (2000). Location, Competition and Economic Development: Local Clusters in a Global Economy. *Economic Development Quarterly*, 14, 65-96.

Rosenfeld, S.A. (1997). Bringing Business Clusters into the Mainstream of Economic Development. *European Planning Studies*, 5, 3-23.

Saxenian, A. (1996). *Regional Advantage: Culture and Competition in Silicon Valley and Route 128*. Cambridge: Harvard University Press.

Steiner, M. (1998). The Discrete Charm of Clusters: An Introduction. In M. Steiner (Eds.), *Clusters and Regional Specialisation* (pp.1-17). London: Pion Limited.

Tabachnick, B.G. & Fidell, L.S. (1996). *Using Multivariate Statistics*. New York: Harper Collins Publishers.

Tichy, G. (1998). Clusters: Less Dispensable and More Risky than Ever. In M. Steiner (Eds.), *Clusters and Regional Specialisation* (pp.226-237). London: Pion Limited.

Waits, M.J. (2000). The Added Value of the Industry Cluster Approach to Economic Analysis, Strategy Development and Service Delivery. *Economic Development Quarterly*, 14, 65-96.

Ward, J. (1963). Hierarchical Grouping to Optimize an Objective Function. *Journal of the American Statistical Association*, 58, 236-244.

APPENDIX

TABLE A1: Competitive Industries in Missouri

IMPLAN Industry	Standard Industrial Classification	Industry Description
SR3	0212,0219,0291	Ranch Fed Cattle
SR7	0213,0219,0291	Hogs, Pigs and Swine
SR12	0115,0139,0191	Feed Grains
SR13	0139,0191,0219	Hay and Pasture
SR14	0139,0191,0219	Grass Seeds
SR21	0116,0119,0139	Oil Bearing Crops
SR30	103X	Lead and Zinc Ores
SR40	141X,142X	Dimension Stone
SR60	2015	Poultry Processing
SR62	2022	Cheese, Natural and Processed
SR63	2023	Condensed and Evaporated Milk
SR69	2035	Pickles, Sauces, and Salad Dressings
SR73	2043	Cereal Preparations
SR77	2047	Dog, Cat, and Other Pet Food
SR78	2048	Prepared Feeds, N.E.C
SR87	2075	Soybean Oil Mills
SR91	2082	Malt Beverages
SR99	2095	Roasted Coffee
SR102	2098	Macaroni and Spaghetti
SR127	2393	Textile Bags
SR129	2395	Pleating and Stitching
SR135	2426	Hardwood Dimension and Flooring Mills
SR136	2429	Special Product Sawmills, N.E.C
SR141	2441,2449	Wood Containers
SR142	2448	Wood Pallets and Skids
SR151	2515	Mattresses and Bedsprings
SR158	2542	Metal Partitions and Fixtures
SR160	2599	Furniture and Fixtures, N.E.C
SR168	2674	Bags, Paper
SR170	2676	Sanitary Paper Products
SR171	2677	Envelopes
SR172	2678	Stationery Products
SR181	277X	Greeting Card Publishing
SR182	2782	Blankbooks and Looseleaf Binder
SR185	2796	Plate Making

TABLE A1: Continued

SR197	2842	Polishes and Sanitation Goods
SR201	2861	Gum and Wood Chemicals
SR204	2879	Agricultural Chemicals, N.E.C
SR206	2892	Explosives
SR211	2951	Paving Mixtures and Blocks
SR212	2952	Asphalt Felts and Coatings
SR217	3052	Rubber and Plastics Hose and Belting
SR221	311X	Leather Tanning and Finishing
SR222	313X	Footwear Cut Stock
SR224	3143,3144,3149	Shoes, Except Rubber
SR225	315X	Leather Gloves and Mittens
SR228	3172	Personal Leather Goods
SR231	3221	Glass Containers
SR232	324X	Cement, Hydraulic
SR235	3255	Clay Refractories
SR245	3274	Lime
SR256	3315	Steel Wire and Related Products
SR261	2819,3334	Primary Aluminum
SR262	3339	Primary Nonferrous Metals, N.E.C.
SR297	3482	Small Arms Ammunition
SR298	3483	Ammunition, Except For Small Arms, N.E.C.
SR304	3495,3496	Miscellaneous Fabricated Wire Products
SR308	3519	Internal Combustion Engines, N.E.C.
SR319	3542	Machine Tools, Metal Forming Types
SR324	3548	Welding Apparatus
SR330	3556	Food Products Machinery
SR334	3564	Blowers and Fans
SR337	3567	Industrial Furnaces and Ovens
SR345	3581	Automatic Merchandising Machine
SR347	3585	Refrigeration and Heating Equipment
SR353	3596	Scales and Balances
SR355	3612	Transformers
SR357	3621	Motors and Generators
SR364	3634	Electric Housewares and Fans
SR374	3669	Communications Equipment N.E.C.
SR379	3691	Storage Batteries
SR380	3692	Primary Batteries, Dry and Wet
SR384	3711	Motor Vehicles
SR387	3715	Truck Trailers

TABLE A1: Continued

SR389	3721	Aircraft
SR393	3732	Boat Building and Repairing
SR395	375X	Motorcycles, Bicycles, and Parts
SR421	3949	Sporting and Athletic Goods, N.E.C.
SR424	3953	Marking Devices
SR433	401X,474X,4789	Railroads and Related Services
SR445	494X,4952	Water Supply and Sewerage Systems
SR486	7941	Commercial Sports Except Racing

NOTES: Standard Industrial Classification (SICs) ending in X includes all industries at the 3-digit level. IMPLAN to SIC bridge taken from IMPLAN.

TABLE 1: Cluster Analysis Agglomeration Schedule

Stage	Number of Clusters	Fusion Coefficient	Slope Percent Change in Fusion Coefficient	Acceleration Percent Change in Slope Coefficient	Mojena Value
479	30	1.6120	3.4660	6.7381	3.3435
480	29	1.6680	3.4739	0.2298	3.3435
481	28	1.7260	3.4772	0.0942	3.3435
482	27	1.7880	3.5921	3.3044	3.3435
483	26	1.8560	3.8031	5.8743	3.3435
484	25	1.9290	3.9332	3.4198	3.3435
485	24	2.0100	4.1991	6.7598	3.3435
486	23	2.0910	4.0299	-4.0299	3.3435
487	22	2.2100	5.6911	41.2225	3.3435
488	21	2.3340	5.6109	-1.4092	3.3435
489	20	2.4770	6.1268	9.1958	3.3435
490	19	2.6250	5.9750	-2.4785	3.3435
491	18	2.7730	5.6381	-5.6381	3.3435
492	17	2.9290	5.6257	-0.2203	3.3435
493	16	3.1050	6.0089	6.8116	3.3435
494	15	3.3210	6.9565	15.7708	3.3435
495	14	3.5730	7.5881	9.0786	3.3435
496	13	3.8440	7.5847	-0.0450	3.3435
497	12	4.1610	8.2466	8.7276	3.3435
498	11	4.7270	13.6025	64.9464	3.3435
499	10	5.3210	12.5661	-7.6191	3.3435
500	9	5.9210	11.2761	-10.2660	3.3435
501	8	6.5940	11.3663	0.8003	3.3435
502	7	7.7310	17.2429	51.7021	3.3435
503	6	8.9170	15.3408	-11.0312	3.3435
504	5	10.6100	18.9862	23.7625	3.3435
505	4	12.5090	17.8982	-5.7305	3.3435
506	3	16.1170	28.8432	61.1515	3.3435
507	2	20.0130	24.1732	-16.1910	3.3435
508	1	36.8940	84.3502	248.9404	3.3435

NOTES: Cluster analysis using Ward's Method and squared Euclidean distance.

TABLE 2: Association Between Competitiveness Clusters and Discriminant Functions

	Discriminant Functions					
Competitiveness Clusters	Function 1: Foreign Export Growth	Function 2: Full Specialization	Function 3: Full Growth Low Productivity	Function 4: Full Growth High Productivity	Function 5: Employment Specialization	Function 6: Foreign Export Specialization
Competitive Fast Growth[a]	-0.28	2.65***	-0.20	-0.48	-0.54	-0.26
Competitive Slow Growth[a]	-0.31	2.65***	-0.56	-0.48	-0.12	-0.32
Emerging Hyper Growth[a]	2.67***	-0.36	-0.33	-0.34	-0.33	-0.33
Emerging Fast Growth[a]	-0.54	0.99	1.71*	1.14	-0.95	-0.85
Emerging Moderate Growth[a]	-0.58	2.53**	-0.66	0.32	-0.19	0.02
Emerging Slow Growth[a]	-0.37	2.59***	-0.64	-0.35	0.26	-0.34
US Average Competitiveness	-0.44	-0.80	-1.40	1.89*	0.26	-0.94
Uncompetitive Hyper Growth	-0.77	-0.39	2.21**	1.15	-0.33	-0.48
Uncompetitive Fast Growth	-0.35	-1.28	1.91*	1.34	-0.46	-0.11
Uncompetitive Slow Growth	-0.16	-2.44**	0.07	1.18	0.09	0.70
Uncompetitive Declining	-0.45	-1.40	-1.42	-0.75	0.64	0.89
Non-Competitive High Productivity	0.07	-0.52	-1.76*	2.14**	-0.09	0.17
Non-Competitive Low Productivity	-0.12	-0.97	1.94*	-1.76*	0.18	0.22

NOTES: z-scores of the canonical discriminant functions evaluated at the cluster means. [a]Competitive clusters.
* Significant at the 90% confidence level. ** Significant at the 95% confidence level. *** Significant at the 99.9% confidence level.

TABLE 3: Competitiveness Cluster Means by Economic Competitiveness Variables

	Economic Competitiveness Variables								
Competitiveness Clusters	Output Specialization	Output Growth	Productivity	Employment Specialization	Employment Growth	Compensation Specialization	Compensation Growth	Foreign Export Specialization	Foreign Export Growth
Competitive Fast Growth[a]	15.36	37.39	1.08	13.18	59.23	17.29	76.90	15.69	27.99
Competitive Slow Growth[a]	8.70	-0.99	0.99	8.41	-0.21	9.15	4.62	8.89	2.79
Emerging Hyper Growth[a]	1.62	385.95	0.86	1.73	381.79	1.48	378.84	1.65	11600.97
Emerging Fast Growth[a]	2.81	170.17	1.12	2.32	163.00	3.24	196.18	1.99	90.46
Emerging Moderate Growth[a]	2.25	10.31	0.97	2.15	11.22	2.30	14.72	2.30	8.03
Emerging Slow Growth[a]	3.93	2.87	0.89	4.10	5.37	3.88	6.34	4.01	8.67
US Average Competitiveness	1.12	-0.85	0.93	1.11	0.64	1.12	-0.06	0.79	-0.93
Uncompetitive Hyper Growth	0.60	603.04	0.87	0.63	465.58	0.41	454.68	0.30	214.86
Uncompetitive Fast Growth	0.35	110.73	0.93	0.34	87.02	0.38	107.83	0.34	91.37
Uncompetitive Slow Growth	0.30	3.65	0.92	0.31	5.62	0.28	7.10	0.28	1.30
Uncompetitive Declining	0.23	-58.38	0.77	0.24	-59.69	0.22	-61.71	0.22	-85.15
Non-Competitive High Productivity	0.39	13.74	5.03	0.07	-20.60	0.05	29.04	0.00	0.00
Non-Competitive Low Productivity	0.04	-0.46	0.04	0.06	3.80	0.03	3.13	0.02	-0.57

NOTES: Calculations based on 2000 data from IMPLAN. [a]Competitive clusters.

TABLE 4: Factor Analysis Results and Pattern Matrix

IMPLAN Industry	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Factor 7	Factor 8	Factor 9
SR3	-0.073	-0.004	**0.764**	-0.061	-0.045	0.033	0.026	0.156	0.150
SR7	-0.074	-0.006	**0.757**	-0.063	-0.046	0.032	0.025	0.159	0.150
SR12	0.063	0.025	**0.905**	0.081	0.010	0.023	0.032	-0.159	-0.063
SR13	0.063	0.025	**0.905**	0.081	0.010	0.023	0.032	-0.159	-0.063
SR14	-0.063	0.018	*0.458* [a]	-0.041	0.083	0.068	0.072	***-0.610*** [a]	0.048
SR21	0.085	0.029	**0.881**	0.039	0.016	0.023	0.022	-0.114	-0.086
SR40	0.223	0.019	0.072	-0.070	**-0.590**	0.030	0.200	0.079	0.007
SR62	0.118	0.009	-0.021	0.019	0.124	0.079	0.057	-0.019	**0.837**
SR63	0.102	0.015	-0.007	-0.050	0.005	0.057	0.024	-0.057	**0.797**
SR69	-0.020	0.066	0.025	**-0.514**	-0.195	0.042	0.109	-0.049	0.273
SR73	0.050	0.086	0.031	**-0.740**	0.044	0.025	0.058	-0.133	0.146
SR77	-0.053	0.115	0.154	**-0.650**	0.017	-0.022	0.008	0.015	0.368
SR78	-0.168	0.043	0.313	-0.134	-0.223	-0.018	0.020	0.145	0.470
SR91	0.002	0.057	-0.070	**-0.563**	-0.202	0.008	0.072	-0.200	0.174
SR99	0.060	0.042	0.097	-0.284	-0.200	0.156	0.240	-0.130	0.137
SR102	0.053	0.082	-0.021	**-0.606**	-0.055	0.071	0.105	-0.261	0.142
SR127	0.266	0.157	0.168	-0.358	-0.211	0.097	0.111	0.126	0.007
SR129	0.271	0.095	0.190	-0.110	-0.278	0.050	0.036	-0.012	-0.041
SR135	-0.013	-0.002	0.029	-0.010	-0.013	**0.918**	-0.007	-0.034	0.055
SR136	0.031	0.114	0.119	0.085	-0.200	**0.631**	0.006	0.073	0.025
SR141	-0.009	0.031	0.027	0.065	-0.030	**0.946**	-0.001	0.031	0.065
SR142	0.020	-0.001	0.000	-0.005	-0.002	**0.955**	-0.002	0.046	0.051
SR151	0.199	0.059	0.073	-0.415	0.012	0.270	0.054	0.096	-0.116
SR158	0.193	0.040	0.045	-0.284	-0.161	0.262	0.187	-0.161	0.020
SR160	-0.014	0.006	0.022	-0.180	0.096	0.319	0.194	-0.047	-0.123
SR168	0.023	0.084	0.115	-0.076	-0.263	0.052	0.083	**-0.521**	0.071
SR170	0.027	0.075	0.030	-0.387	-0.152	0.102	0.152	-0.390	0.109
SR171	0.036	0.044	0.062	-0.295	-0.263	0.175	0.136	-0.314	0.054
SR172	0.009	0.026	0.086	-0.239	-0.250	0.202	0.155	-0.307	0.063
SR181	0.305	0.053	0.355	-0.416	-0.090	0.034	-0.031	0.009	-0.121
SR182	0.173	0.092	0.098	-0.451	-0.140	0.086	0.118	-0.137	0.044
SR185	0.317	0.106	0.206	-0.210	-0.301	0.080	0.138	0.098	-0.003
SR197	0.158	0.102	0.083	-0.212	-0.135	0.027	0.030	-0.471	0.162
SR201	0.028	0.040	-0.032	0.095	-0.328	0.446	-0.094	-0.306	0.114
SR204	0.107	0.139	0.126	-0.099	-0.299	-0.026	0.033	-0.376	0.180
SR206	0.255	0.029	0.171	-0.045	-0.403	0.043	-0.002	-0.103	-0.009
SR211	0.070	0.094	0.081	-0.132	**-0.556**	0.048	0.087	-0.116	0.057

TABLE 4: Continued

SR212	0.099	0.088	0.019	-0.347	-0.409	0.065	0.137	-0.036	0.084
SR217	0.157	0.126	0.129	-0.087	-0.295	0.039	0.107	-0.353	0.081
SR221	-0.027	**0.855**	0.123	0.202	-0.056	-0.012	0.010	-0.136	0.076
SR222	-0.056	**1.007**	0.014	0.213	0.035	0.042	0.026	-0.004	0.024
SR224	0.031	**0.811**	0.004	-0.212	0.060	0.017	0.085	-0.049	0.007
SR225	-0.061	**1.021**	-0.118	-0.046	0.008	-0.038	-0.071	0.092	-0.044
SR228	0.143	**0.826**	0.007	-0.214	-0.022	-0.007	0.002	0.096	-0.070
SR231	-0.020	0.017	0.005	-0.196	*-0.386* [a]	-0.016	0.088	***-0.521*** [a]	0.102
SR232	0.040	0.047	0.026	-0.005	**-0.834**	0.100	0.058	0.018	0.001
SR235	-0.114	0.104	0.107	0.071	**-0.627**	0.213	0.062	-0.088	0.006
SR245	-0.015	0.047	0.024	0.025	**-0.836**	0.091	0.007	-0.073	-0.001
SR256	0.245	0.046	0.133	-0.005	-0.365	0.126	0.253	-0.033	0.050
SR261	0.011	0.053	-0.001	0.025	**-0.798**	0.003	0.090	-0.006	0.024
SR297	0.138	0.084	-0.041	-0.240	-0.223	0.285	0.076	-0.276	0.068
SR298	**0.485**	0.060	0.081	0.058	-0.253	0.100	0.083	-0.164	0.097
SR304	0.290	0.054	0.112	-0.183	-0.238	0.182	0.254	0.065	-0.009
SR308	-0.007	0.015	0.022	0.053	-0.073	-0.099	**0.969**	0.019	0.010
SR319	0.362	0.062	0.087	-0.059	-0.172	0.208	0.317	0.021	0.035
SR324	0.238	0.066	0.156	-0.125	-0.119	0.142	0.198	-0.271	0.051
SR330	0.343	0.044	0.070	-0.152	-0.071	0.207	0.362	0.030	0.036
SR334	0.291	0.054	0.035	-0.160	-0.097	0.078	0.462	-0.072	0.021
SR337	**0.573**	0.063	0.090	-0.075	-0.146	0.185	0.198	0.129	0.037
SR345	*0.320* [a]	0.039	0.032	0.009	-0.028	0.047	***0.490*** [a]	-0.139	0.076
SR347	0.224	0.017	-0.011	0.039	-0.029	0.040	**0.584**	-0.127	0.086
SR353	**0.673**	0.058	-0.026	-0.192	0.007	0.000	-0.018	-0.133	0.107
SR355	0.317	0.028	0.081	-0.113	-0.132	0.225	0.284	-0.059	0.082
SR357	0.198	0.017	0.015	-0.041	-0.037	-0.049	**0.735**	-0.126	0.044
SR364	0.416	0.068	0.017	-0.178	-0.002	0.017	0.296	-0.238	0.053
SR374	**0.875**	0.026	0.048	0.075	0.034	0.009	-0.012	0.013	0.099
SR379	0.174	0.070	0.164	-0.118	-0.183	0.079	0.215	-0.208	0.131
SR380	0.134	0.083	0.085	-0.103	-0.202	0.032	0.155	-0.425	0.092
SR384	-0.029	0.015	-0.016	0.027	-0.038	-0.020	**0.782**	0.032	0.060
SR387	-0.116	-0.006	-0.014	0.035	-0.019	0.276	**0.789**	0.033	0.044
SR389	**0.665**	0.050	0.011	0.070	-0.133	0.033	0.161	0.039	0.108
SR393	-0.079	0.029	0.081	0.008	0.045	0.007	**0.875**	-0.014	-0.061
SR395	0.070	0.081	0.071	-0.139	-0.034	0.030	**0.728**	0.082	0.052
SR421	0.362	0.168	0.059	-0.307	0.125	0.215	0.085	-0.198	0.116
SR424	0.269	0.076	0.189	-0.161	-0.131	0.139	0.080	-0.203	0.066

TABLE 4: Continued

Eigen Value	44.260	3.002	2.902	2.659	2.178	1.781	1.554	1.339	1.134
Percent Variance Explained	59.0%	4.0%	3.9%	3.5%	2.9%	2.4%	2.1%	1.8%	1.5%

NOTES: Principal components factor analysis using oblique rotation.
High factor loadings in bold. [a]Crossloading industry.

TABLE 5: Supplier-Based Industry Clusters in Missouri

Supplier-Based Cluster	IMPLAN Industry	Industry Description
Precision Products	*SR298*	Ammunition, Except Small Arms
Factor 1	*SR337*	Industrial Furnaces & Ovens
	SR353	Scales & Balances
	SR374	Communications Equipment, NEC
	SR389	Aircraft
Leather Products	*SR221*	Leather Tanning & Finishing
Factor 2	*SR222*	Footwear Cut Stock
	SR224	Shoes, Except Rubber
	SR225	Leather Gloves & Mittens
	SR228	Personal Leather Goods
Livestock	*SR3*	Ranch Fed Cattle
Factor 3	*SR7*	Hogs, Pigs & Swine
	SR12	Feed Grains
	SR13	Hay & Pasture
	SR21	Oil Bearing Crops
Food Grain Products	*SR69*	Pickles, Sauces & Salad Preparations
Factor 4	*SR73*	Cereal Preparations
	SR77	Dog, Cat & Other Pet Food
	SR91	Malt Beverages
	SR102	Macaroni & Spaghetti
Stone & Clay Products	*SR40*	Dimension Stone
Factor 5	*SR211*	Paving Mixtures and Blocks
	SR232	Hydraulic Cement
	SR235	Clay Refractories
	SR245	Lime
	SR261	Primary Aluminum
Wood Products	*SR135*	Hardwood Dimension & Flooring Mills
Factor 6	*SR136*	Special Product Sawmills, NEC
	SR141	Wood Containers
	SR142	Wood Pallets & Skids

TABLE 5: Continued

Motorized Products	*SR308*	Internal Combustion Engines, NEC
Factor 7	*SR345*[a]	*Automatic Merchandising Machines*[a] *(Crossloads on Factor 1)*
	SR347	Refrigeration & Heating Equipment
	SR357	Motors & Generators
	SR384	Motor Vehicles
	SR387	Truck Trailers
	SR393	Boat Building & Repair
	SR395	Motorcycles, Bicycles & Parts
Container Products	*SR14*[a]	*Grass Seeds*[a] *(Crossloads on Factor 3)*
Factor 8	*SR168*	Paper Bags
	SR231[a]	*Glass Containers*[a] *(Crossloads on Factor 5)*
Food Dairy Products	*SR62*	Natural & Processed Cheese
Factor 9	*SR63*	Condensed & Evaporated Milk

NOTES: [a]Crossloading industry.

TABLE 6: Missouri Commodities Purchased by Supplier-Based Industry Cluster

Supplier-Based Cluster	IMPLAN Industry	Missouri Commodity Purchased	Percent
Precision Products	*SR378*	Electric Components, NEC	7.11%
	SR447	Wholesale Trade	7.09%
	SR435	Motor Freight Transportation & Warehousing	1.91%
	SR456	Banking	1.62%
	SR377	Semiconductors	1.26%
	SR389	Aircraft	1.10%
	SR462	Real Estate	1.09%
	SR475	Computer & Data Processing Services	1.01%
	SR494	Legal Services	0.92%
	SR441	Communications, Except Radio & TV	0.92%
	SR376	Printed Circuit Boards	0.88%
	SR56	Facility Maintenance & Repair Services	0.86%
		All Missouri Commodities	42.14%
Leather Products	*SR221*	Leather Tanning & Finishing	22.59%
	SR447	Wholesale Trade	3.90%
	SR435	Motor Freight Transportation & Warehousing	2.40%
	SR58	Meat Packing Plants	2.14%
	SR56	Facility Maintenance & Repair Services	1.88%
	SR456	Banking	1.64%
	SR190	Industrial Organic Chemicals	1.25%
	SR441	Communications, Except Radio & TV	0.93%
	SR512	Other State & Local Government Enterprises	0.85%
		All Missouri Commodities	51.29%
Livestock	*SR462*	Real Estate	11.54%
	SR447	Wholesale Trade	9.86%
	SR204	Agricultural Chemicals, NEC	5.29%
	SR7	Hogs, Pigs & Swine	3.24%
	SR435	Motor Freight Transportation & Warehousing	3.21%
	SR3	Ranch Fed Cattle	3.04%
	SR56	Facility Maintenance & Repair Services	2.80%
	SR26	Agricultural Services	2.67%
	SR12	Feed Grains	2.03%
	SR13	Hay & Pasture	1.70%
	SR21	Oil Bearing Crops	1.66%
	SR213	Lubricating Oils & Greases	0.92%
		All Missouri Commodities	59.53%

TABLE 6: Continued

Food Grain Products	*SR447*	Wholesale Trade	10.52%
	SR164	Paperboard Containers & Boxes	5.26%
	SR442	Radio & TV Broadcasting	3.43%
	SR179	Commercial Printing	3.35%
	SR435	Motor Freight Transportation & Warehousing	3.22%
	SR469	Advertising	3.15%
	SR174	Newspapers	2.59%
	SR231	Glass Containers	2.25%
	SR87	Soybean Oil Mills	2.01%
	SR470	Other Business Services	1.78%
	SR456	Banking	1.42%
	SR273	Metal Cans	1.35%
	SR433	Railroads & Related Services	1.29%
	SR56	Facility Maintenance & Repair Services	1.18%
	SR471	Commercial Photography	0.94%
		All Missouri Commodities	57.64%
Stone & Clay Products	*SR435*	Motor Freight Transportation & Warehousing	10.38%
	SR443	Electric Services	6.65%
	SR447	Wholesale Trade	5.16%
	SR444	Gas Production & Distribution	5.08%
	SR56	Facility Maintenance & Repair Services	1.87%
	SR456	Banking	1.68%
	SR475	Computer & Data Processing Services	1.42%
	SR433	Railroads & Related Services	1.41%
	SR512	Other State & Local Government Enterprises	0.95%
	SR206	Explosives	0.85%
		All Missouri Commodities	51.27%
Wood Products	*SR134*	General Sawmills & Planing Mills	22.09%
	SR447	Wholesale Trade	14.24%
	SR435	Motor Freight Transportation & Warehousing	6.45%
	SR133	Logging Camps & Contractors	3.36%
	SR456	Banking	1.73%
	SR443	Electric Services	1.60%
	SR56	Facility Maintenance & Repair Services	1.59%
	SR441	Communications, Except Radio & TV	1.42%
	SR512	Other State & Local Government Enterprises	1.27%
	SR462	Real Estate	0.95%
		All Missouri Commodities	66.69%

TABLE 6: Continued

Motorized Products	*SR447*	Wholesale Trade	9.62%
	SR308	Internal Combustion Engines, NEC	6.71%
	SR347	Refrigeration & Heating Equipment	2.62%
	SR435	Motor Freight Transportation & Warehousing	2.53%
	SR386	Motors Vehicle Parts & Accessories	1.66%
	SR357	Motors & Generators	1.23%
	SR456	Banking	1.16%
	SR384	Motor Vehicles	0.83%
	SR56	Facility Maintenance & Repair Services	0.81%
		All Missouri Commodities	41.76%
Container Products	*SR164*	Paperboard Containers & Boxes	15.40%
	SR447	Wholesale Trade	8.99%
	SR435	Motor Freight Transportation & Warehousing	5.31%
	SR204	Agricultural Chemicals, NEC	2.89%
	SR191	Plastics Materials & Resins	2.46%
	SR56	Facility Maintenance & Repair Services	2.28%
	SR443	Electric Services	2.10%
	SR444	Gas Production & Distribution	1.56%
	SR462	Real Estate	1.52%
	SR190	Cyclic Crudes & Industrial Organic Chemicals	1.31%
	SR456	Banking	1.27%
	SR433	Railroads & Related Services	1.25%
	SR213	Lubricating Oils & Greases	0.88%
	SR475	Computer & Data Processing Services	0.87%
		All Missouri Commodities	61.98%
Food Dairy Products	*SR1*	Dairy Farm Products	14.18%
	SR62	Natural & Processed Cheese	11.21%
	SR447	Wholesale Trade	7.08%
	SR63	Condensed & Evaporated Milk	7.06%
	SR164	Paperboard Containers & Boxes	1.88%
	SR65	Fluid Milk	1.58%
	SR456	Banking	1.34%
	SR435	Motor Freight Transportation & Warehousing	0.93%
		All Missouri Commodities	57.65%

NOTE: Percent is the cluster mean for all industries of commodities purchased from Missouri. Calculations based on 2000 data from IMPLAN.

TABLE 7: Economic Impacts of the Supplier-Based Industry Clusters in Missouri

	Economic Variables				
Supplier-Based Cluster	Output (Pct of MO Total)	Employment (Pct of MO Total)	Compensation (Pct of MO Total)	Foreign Exports (Pct of MO Total)	Wage Per Job (Pct of MO Avg)
Precision Products	$5,130,979,000 (1.55%)	22,083 (0.63%)	$1,505,286,000 (1.43%)	$2,451,380,000 (11.92%)	$68,165 (227.82%)
Leather Products	$358,006,000 (0.11%)	3,109 (0.09%)	$101,959,000 (0.10%)	$154,410,000 (0.75%)	$32,795 (109.61%)
Livestock	$3,626,770,000 (1.10%)	89,370 (2.53%)	$504,175,000 (0.43%)	$540,920,000 (2.63%)	$5,641 (18.85%)
Food Grain Products	$5,950,461,000 (1.80%)	11,299 (0.32%)	$822,561,000 (0.78%)	$235,890,000 (1.15%)	$72,799 (243.31%)
Stone & Clay Products	$1,803,910,000 (0.55%)	8,310 (0.24%)	$413,995,000 (0.39%)	$89,630,000 (0.44%)	$49,819 (166.50%)
Wood Products	$405,094,000 (0.12%)	5,420 (0.15%)	$122,633,000 (0.12%)	$16,640,000 (0.08%)	$22,626 (75.62%)
Motorized Products	$16,396,064,000 (4.96%)	42,416 (1.20%)	$2,678,676,000 (2.54%)	$2,585,190,000 (12.57%)	$63,152 (211.07%)
Container Products	$453,009,000 (0.14%)	17,420 (0.49%)	$94,007,000 (0.08%)	$51,560,000 (0.25%)	$5,396 (18.04%)
Food Dairy Products	$1,929,823,000 (0.58%)	4,008 (0.11%)	$174,317,000 (0.17%)	$67,860,000 (0.33%)	$43,492 (145.36%)

NOTE: Calculations based on 2000 data from IMPLAN.

FIGURE 1: Cluster Blueprint