Benchmark value chain industry clusters for applied regional research

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Abstract

It is common in regional industry cluster analysis to begin by exploring recent economic trends using cluster "benchmarks" as a unit of analysis. Industry cluster benchmarks are pre-defined sets of related sectors that have been identified based on an analysis of interindustry relationships at a geographic scale other than the region under study, usually the nation as a whole. Examples are manufacturing value chain clusters derived by Feser and Bergman (2000) using 1987 national input-output data and Porter's (2003) a set of geography-based clusters derived from a joint analysis of industry co-location patterns and trading linkages. In this paper, I develop and implement an alternative methodology for identifying benchmark value chain clusters useful for applied regional economic base studies. The approach addresses several key weaknesses in the Feser and Bergman methodology while also updating the value chain benchmarks to the 2002 North American Industry Classification System.

Introduction

Industry cluster studies are an increasingly popular type of applied regional economic analysis. Isserman (2005) has suggested that they are essentially a modern version of the detailed community economic base study as implemented in such classic applications as 1929 *Regional Survey of New York and its Environs*. Regional industry cluster studies usually involve extensive analysis of the characteristics and competitive foundations of the local industrial base, regional linkages with the national and global economies, and

formal and informal networking behavior by local businesses. The results may inform a very wide range of public sector interventions, from industry targeting and industrial recruitment to investments in research and development facilities in area universities. Feser and Luger (2002) argue that regional cluster analysis should be viewed as a "flexible mode of inquiry" rather than a single identifiable methodology. While the unifying feature of such studies is the importance they ascribe to business and sectoral interdependence, a variety of qualitative and quantitative research designs and specific analytical techniques might be appropriate depending on the planning and policy concerns at hand. In this sense, the observed variation in methodologies should not be viewed as symptomatic of the conceptual incoherence of the cluster concept, or as a failure of the academic community to develop a single optimal approach, but rather as wholly appropriate given varying planning needs of different locales.

Many applied regional cluster studies begin by exploring local industry trends using a "benchmark" cluster classification scheme. Industry cluster benchmarks are pre-defined sets of related sectors that have been identified based on an analysis of interindustry relationships at a geographic scale other than the region under study, usually the nation as a whole (Bergman and Feser, 1999). For example, Bergman et al. (1996) developed a set of 24 benchmark value-chain clusters within manufacturing using national input-output data and applied them to an analysis of North Carolina's economic base. Their methodology is detailed in Bergman and Feser (1999) and Feser and Bergman (2000). More recently, in an approach reminiscent of early industry complex studies (e.g., Bergsman, Greenston et al., 1975), Porter (2003) uses *County Business Patterns* data to analyze the co-location of industries across states. He identifies three sets of benchmark clusters: sixteen that are locally-oriented, ten that are resource dependent, and 41 that are traded or export-oriented. Users can utilize an online tool maintained by the Harvard Business School to download *County Business Patterns* data for their county or state already aggregated to Porter's benchmarks.[1]

This paper develops and implements a new methodology for identifying benchmark value chain clusters from a systematic analysis of intermediate purchasing and sales patterns as revealed in the *Benchmark Input-Output Accounts of the United States, 1997*. The methodology combines an original customized algorithm for defining a

strength-of-linkage measure for all pairs of input-output sectors with application of a standard Ward's hierarchical clustering algorithm.[2] I define two sets of 1997 value chain clusters: 1) a full set covering all sectors in the U.S. except government enterprises and a very limited set of purely local-serving industries (e.g., retail, personal services, and elementary and secondary schools); and 2) a reduced set comprised of high technology sectors only.[3] The clusters are not mutually exclusive, as appropriate given the focus on interdependence in the cluster model.

The set of national benchmark value chain clusters reported here have the following features, some of which represent conceptual improvements over earlier value chain versions in Feser and Bergman (2000) and Feser and Koo (2000). First, the chains were developed through an analysis of detailed input-output flows in both manufacturing and non-manufacturing industries, assessed in a single comprehensive methodology. The 1987 version was restricted to manufacturing while the 1992 version included non-manufacturing industries in an informal, second-stage procedure. Second, they utilize the 2002 NAICS industry classification system, facilitating their use with the latest regional economic data series. Third, they include a more directly interpretable "linkage coefficient" that summarizes the strength of the "tie" between a given sector and the clusters in which it is a member. Finally, the revised methodology eliminates a key limitation of earlier approaches, namely the tendency of statistical factor analysis to produce a few very large composite clusters and many smaller, single-member clusters. Therefore, the benchmark clusters are both more detailed and somewhat more evenly distributed in size of membership than in prior versions.

Methodology

The point of departure is a 489 x 489 inter-industry transactions matrix, **A**, from the U.S. 1997 benchmark accounts. Two ratios are calculated from **A**:

$$x_{ij} = \frac{a_{ij}}{a_{+j}} \tag{1}$$

$$y_{ij} = \frac{a_{ij}}{a_{i+}} \tag{2}$$

A cell in a given column vector in **X** reports the ratio of purchases by column industry *j* from row industry *i* to total intermediate purchases by industry *j*, or *j*'s intermediate input purchasing pattern. A cell in a given column in $\mathbf{Y}'$ reports the ratio of sales of row industry *i* to column industry *j* to total intermediate sales by industry *i*, or *i*'s intermediate selling pattern. The columns of **X** ($\mathbf{Y}'$) are simply vectors of shares of total dollar purchases (sales) of each industry *j* from all other industries *i*.

A number of procedures might be applied to **X** and $\mathbf{Y}'$ to identify sectors in common value chains. Czamanski (1974) defined four correlations intended to capture similarities in each pair of sectors' purchasing and sales patterns. He then selected the largest of those correlations for each sector pair and applied data reduction methods to group industries together in what he called industrial clusters. Feser and Bergman (2000) used U.S. 1987 benchmark input-output data, the four Czamanski correlations, and factor analysis to identify 23 value chains in manufacturing. Feser and Koo (2000) used the same basic strategy to produce updated value chains based on U.S. 1992 input-output data. They also extended the industrial coverage to selected non-manufacturing industries (primarily business and information services). Both the 1987 and 1992 value chains utilized the 1987 Standard Industrial Classification (SIC) system.

Input-output data are an extremely rich source of information on inter-industry relationships. Critical to their use in applied regional economic applications is the notion that national input-output relationships are appropriate for first defining benchmark buyer-supplier chains that may then be used to analyze geographic patterns among related industries. The key questions in most applied industry cluster studies are: first, which industries are fundamentally related in some functional sense; and, second, where are those industries located? Or, for the local analyst, which of the industries in given chains are concentrated in the study region? Benchmark value chains derived from *national* input-output data provide a systematic means of answering those questions. They are derived using independently verifiable methods and actual information on inter-industry relationships. This contrasts with approaches that define functionally linked sectors based largely on expert opinion and/or little inter-industry data. It also contrasts with geography-based approaches such as Porter (2003), who uses revealed industrial location patterns to first detect groups of related sectors and then 1992 national input-output data

to reduce each group to only those sectors are functionally linked via trade. Thus Porter's benchmarks attempt to isolate sectors that are *both* trading and commonly co-located, at least as indicated with state-level data.

An explicit aim of the methodology developed in this paper is *not* to confound geography and industrial interdependence. The logic is that some industries are linked in economic space but not geographic space (Perroux, 1950; Perroux, 1988). It is often useful for regional analysts to know in which segments of given national value chains their region is specialized. It may also be useful under certain circumstances for an analyst to know whether his or her region is specialized in groups of trading industries that are commonly co-located, as revealed in the Porter benchmarks. Again, as noted in the introduction, the utility of given sets of benchmark clusters will vary depending on the planning or policy application at hand.

Several challenges beset attempts to find industry value chains using detailed input-output data. First, while standard data reduction techniques are simple to apply given the availability of canned software algorithms, they are rarely appropriate for the analysis of input-output data without significant modification. Factor analysis, for example, aims to find the fewest common dimensions among a set of variables; it is, after all, a data reduction technique. Applied to input-output data, factor analysis often loads a very large number of industries on the first few factors, and progressively many fewer industries on subsequent factors, yielding a highly uneven set of value chains. As a result, the first factors tend to contain a very large number of relatively diverse industries. For example, Feser and Bergman's 1987 metalworking value chain, the first factor in their analysis, contains over 100 of 362 manufacturing sectors.

In contrast to factor analysis, statistical cluster analysis algorithms tend to yield more even clusters (in terms of numbers of member sectors). However, most cluster algorithms produce mutually exclusive industry groupings, a theoretically indefensible result. Obviously, what one would wish to avoid are algorithms that are predisposed *a priori* toward finding even, uneven, mutually exclusive, or overlapping (sometimes called "fuzzy") clusters. The ideal would be to allow the data to speak for themselves. However, most predefined algorithms have a normative element to them and were first

designed for specific research problems to which the value chain question may or may not conform.

Second, the detailed statistical output of many data reduction techniques is difficult to interpret and is therefore often of limited utility for explicating the specific features of identified value chains. At a minimum, data reduction output is generally of little use to development practitioners interested in using a given set of value chain definitions. The typical analyst is rarely intimately familiar with statistical factor and cluster analysis methodologies. Therefore, even if researchers supplied the statistical output along with the final set of industry cluster or value chain definitions, few applied analysts would make use of it.

Third, some of the most theoretically appealing data reduction algorithms are difficult to apply to data matrices containing hundreds of variables (sectors). An example is the fuzzy clustering algorithm outlined in Kaufman and Rousseeuw (1990) and implemented in S-Plus software. Dridi and Hewings (2003) successfully apply the approach as a means of avoiding mutual exclusivity in industry cluster definitions. However, their input-output table contains comparatively few sectors. The problem with available fuzzy clustering algorithms is that they generate an extraordinary volume of output that must be sifted through to interpret cross-cluster linkages. They are thus impractical for applications involving a large number of sectors. Initial tests of fuzzy cluster algorithms by this author with the full U.S. inter-industry transactions matrix (489 sectors) proved unsuccessful simply because the matrix was prohibitively large.

Back to basics: Defining the problem

Industry *i*'s value chain consists of 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, we are interested in identifying a reduced number of value chains that are, in essence, 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 sectors outside the group. Such groups would then become useful units of analysis for understanding industrial location patterns as well as specific industry concentrations (and mixes) in individual regions. In

effect, the chains become alternative industrial units of analysis in studies of regional economies.

Intuitively, what we would like to do is to compare the linkage patterns of each pair of industries in order to assess the degree of overlap between them. Depending on how we specify the parameters of that comparison, different types of clusters can be derived. In the Czamanski approach, linkage patterns along four dimensions are compared by calculating pairwise correlations on industry purchasing and sales vectors derived directly from the input-output transactions matrix. The maximum correlation, the indicator of the strength of linkage between each pair of sectors, is then used to form a square matrix for analysis with data reduction techniques.

A comparison of sets

Here a simpler approach is proposed, one that is both more intuitive and more flexible with regard to subsequent value chain analysis. It begins 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. 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 might set a threshold, α, that x_{ij} and y_{ij} must exceed in order for sector j (i) to be included in sector i's (j's) set of key suppliers (or buyers). Given S and B, define:

$$\begin{aligned} I_{ij}^{SS} &= S_i \cap S_j, \quad U_{ij}^{SS} = S_i \cup S_j \\ I_{ij}^{BB} &= B_i \cap B_j, \quad U_{ij}^{BB} = B_i \cup B_j \\ I_{ij}^{SB} &= S_i \cap B_j, \quad U_{ij}^{SB} = S_i \cup B_j \\ I_{ij}^{BS} &= B_i \cap S_j, \quad U_{ij}^{BS} = B_i \cup S_j \end{aligned} \tag{3}$$

Then construct the following four measures:

$$R_{ij}^{SS} = \frac{I_{ij}^{SS}}{U_{ij}^{SS}}, \quad R_{ij}^{BB} = \frac{I_{ij}^{BB}}{U_{ij}^{BB}}, \quad R_{ij}^{SB} = \frac{I_{ij}^{SB}}{U_{ij}^{SB}}, \quad R_{ij}^{BS} = \frac{I_{ij}^{BS}}{U_{ij}^{BS}} \tag{4}$$

The ratios in (4) are measures of shared linkages between sectors i and j along four dimensions. For example, R^{SS} is the number of supplier sectors that industries i and j have in common over the total number (or universe) of supplier sectors 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 sectors.

R^{SB} and R^{BS} are measures of second-tier relationships between each pair of sectors; they increase as one sector's suppliers are another's buyers.

The shares in (4) lend themselves to the construction of a dissimilarity matrix that is improved over the Czamanski correlation matrix in two particular respects. First, the Pearson product moment correlation coefficient used by Czamanski is highly sensitive to outliers, a very significant problem due to the nature of input-output flows and prevailing industrial accounting schemes. A comparatively few general producer services industries supply a majority of industries. Examples are wholesaling, legal services, the information sector, and financial services. Moreover, the total volume of dollar purchases of any given industry *i* from sectors like wholesale trade is typically large relative to purchases from more specialized industries. A contributing factor is that the level of sectoral disaggregation in the input-output accounts varies by broad sector, from a high degree of disaggregation in manufacturing to a relatively low degree in services and wholesale trade. Because of the skewed nature of dollar purchases by industry, with most industries making major purchases from the same limited set of general sectors and comparatively small purchases from many very different specialized sectors, purchasing correlation coefficients between industries tend to be inflated and overly uniform. When data reduction algorithms are applied to such correlations as the indicators of dissimilarity there is often insufficient variation to derive distinct industry groupings.[4] The result is some very odd bedfellows among the resulting clusters.

The shares, in effect, 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.[5] Alternatively, we might weight certain pairwise linkages more than others. In the analysis here, sectors such as wholesale trade, information, legal services, advertising, finance, and insurance are defined as "enabling industries" and are assigned a weight (<1.0) that reduces their influence in the calculation of the *R* measures. The goal was to allow the distinct or unique linkages between sectors to define the value chains rather than the joint consumption of broadly similar mixes of producer services, but yet not to exclude linkages with producer services entirely. Note that other weighting schemes could be employed depending on the question at hand. For example, one could imagine weighting

technology sectors more than others as a means of emphasizing technology-based linkages.

The second problem with the Czamanski correlation approach that the *R* measures solve is with regard to interpretability, particularly once the value chains are identified. Each indicator in (4) may be interpreted as a simple share of common linkages and therefore as a straightforward measure of the tie between two sectors. Factor loadings, or even correlation coefficients on pairwise purchase/sales vectors, are more difficult to explain to potential value chain users and policy makers.

Implementation

Figure 1 summarizes the implementation of the approach with 1997 benchmark U.S. input-output data.[6]

Local serving sectors and link threshold. The initial 489 sector inter-industry transactions matrix is reduced to a 463 dimension matrix by eliminating the 26 primarily local serving and government enterprise sectors listed in Table 1. The measures *R* are then calculated after setting $\alpha = 0.02$ for purchases and 0.01 for sales. Industry *j* must represent at least 2 percent of industry *i*'s total intermediate input purchases to be considered one of *i*'s key suppliers. Similarly, *j* must account for at least 1 percent of *i*'s intermediate sales to be considered one of *i*'s key buyers. These levels were selected after inspecting purchasing and sales patterns in the transactions matrix.

Enabling sector weight. In addition to α, a weight of one-third or 0.33 was applied to each of 55 enabling industries (listed in Table 2) in the calculation of the *R* measures. The weight, which is essentially arbitrary, discounts a linkage between industry *i* and a general enabling industry by two-thirds, thereby serving to emphasize linkages among more specialized industries. The groupings generated by statistical cluster analysis with weights of 0.75, 0.5, 0.33 and 0.25 on the enabling sector were compared to determine the degree to which weighted enabling linkages tended to dominate identification of the value chains. The notion was to select the maximum weight that still yielded distinct chains. The level 0.33 met this criterion.

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 the 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.

Singletons. Selecting the maximum of the four *R* measures produces a 463-dimension linkage matrix ($\mathbf{R}^{\mathbf{MAX}}$) that can be analyzed with data reduction techniques. Prior to this step, however, it is useful to calculate the average number of linkages identified for each industry. The great majority of industries post more than twenty linkages at an R^{MAX} threshold of 0.40. However, 32 of 463 sectors post very few linkages at any R^{MAX} threshold. They are sectors whose predominant intermediate transactions are either with themselves or with primarily local serving industries eliminated from the reduced transactions matrix. Such sectors (listed in Table 3) may be regarded as essentially independent, or as "singletons" (or "isolates") in a network analysis context. They were eliminated from the linkage matrix prior to the statistical cluster analysis. Eliminating the 32 isolates yields a linkage matrix with 431 industries.

Singletons are reintroduced into the analysis in two ways. First, two sets of singleton sectors contain highly linked industries such that they form small clusters. Input-output (IO) sectors 312120 (breweries) and 312140 (distilleries) form a small core breweries and distilleries chain. IO sectors 316100 (leather and hide tanning and finishing), 316200 (footwear manufacturing), and 316900 (other leather product manufacturing) form a leather products chain. These two core chains are added to the set derived from statistical cluster analysis described below.

The second way singletons re-enter the analysis is after the identification of the core chains. At that point, the linkages between each industry *i* and the set of industries in each of the identified core chains were inspected. Singletons, along with other sectors, are assigned as "secondary" sectors to the core chains for which they post the strongest average linkage. This may be clearer in the discussion that follows.

Core clusters. The 437-dimension square linkage matrix was analyzed using Ward's hierarchical clustering algorithm. Initial inspection of the results suggested a solution of between 40 and 50 distinct clusters. All cluster splits for solutions between 30 and 60 clusters were then examined to identify the solution that met both statistical and interpretability criteria. That solution proved to be 43 distinct clusters or value chains.

Together with breweries/distilleries and leather products, 45 mutually exclusive groups of industries were thus identified at this stage.

"Fuzzing" the clusters. It is important to remember 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 45 clusters are simply more strongly related to each other than they are to other identified groups. It is still the case that any particular industry may also have reasonably tight linkages with other value chains.

This inherent "fuzziness" among inter-industry linkages can be 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 sector, *s*, is defined as a "secondary" sector to a given value chain if its average linkage with primary industries of that chain exceeds some threshold, δ. Progressively lower levels of δ increase 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. Define for each sector *i* its average linkage (from $\mathbf{R}^{\mathbf{MAX}}$) across *n* primary sectors *j* in cluster *k*:

$$\overline{r}_{ik} = \frac{\sum_{j=1}^{n} r_{ijk}^{MAX}}{n} \tag{5}$$

In other words, $\overline{r}_{ik}$ is the average value of the maximum linkage between industry *i* and the set of primary industries in core cluster *k*. The values $\overline{r}_{ik}$ can be arrayed in a 463 row by 45 column matrix. The $\overline{r}_{ik}$ are converted to *z* scores in the usual fashion:

$$z_{ik} = \frac{\overline{r}_{ik} - mean(\overline{r}_{ik})}{s.d.(\overline{r}_{ik})} \tag{6}$$

Each industry *i* was defined as a secondary industry in cluster *k* where $z_{ik} > 2.25$.

Appendix Table 1 reports the detailed makeup of each of the 45 benchmark clusters as well as the average linkage indicator and its *z* score. The higher the linkage factor, the more closely the sector is tied to the cluster (or the more closely its value chain

aligns with that of the other cluster members). The descriptor for each cluster represents the predominant economic activity among the group of sectors, particularly those that are most tightly linked within the cluster. They should be interpreted carefully. No descriptor can adequately capture all of the relationships among sectors in each cluster. Some of the features of the benchmark value chain clusters are the following:

- They are considerably more detailed than earlier benchmarks developed with 1987 and 1992 input-output data. This reflects the inclusion of additional non-manufacturing industries, increased refinement of NAICS-based input-output data, and the use of the more sophisticated clustering algorithm that separates strong and weak linkages with greater precision. To an unknown degree, it also reflects shifts in the industrial structure and technology of the U.S. economy
- While the clusters appear to correspond to basic industry categories, many are comprised of sectors that fall into multiple industries, or two and three digit NAICS codes. For example, the chemicals-based products cluster includes paper and paperboard bills (NAICS 3221), phosphatic fertilizers (NAICS 3253), and carbon and graphite products (NAICS 3359), among others.
- The descriptor for each cluster represents the predominant economic activity among the group of sectors, particularly those that are most tightly linked within the cluster. Note that no descriptor can adequately capture all of the relationships among sectors in each cluster.
- The industries included in the benchmarks 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. 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.
- Even though NAICS is an improvement over the SIC system, the cluster results are still influenced by limitations in the federal government's industry classification system. Some fast growing technology industries, such as biotechnology and specialized information technology, are not easily detected since many such sectors remain roughly defined even under the more extensive

NAICS system. Biotechnology tends to be captured in the pharmaceuticals and hospitals/medical technologies clusters, as well as the chemicals cluster.

- An important feature of the benchmark clusters is that they are based on a systematic analysis of observed ties between industries. This means that all sectors are treated consistently at the start and that a given industry's membership in a value chain is objectively assessed.
- The benchmark clusters are exactly that—*benchmarks*. They are based on *national* trading patterns and do not reflect regional trading relationships. Their purpose is to indicate which sectors might be trading locally or which types of sectors businesses might benefit from if co-located nearby.

U.S. value chain trends

Table 4 lists the 45 general U.S. benchmark value chain clusters along with recent basic payroll, wage, and employment information. The largest value chain cluster in the U.S. is research, higher education and hospitals, a cluster comprised of several large U.S. services industries that engage in significant volumes of trade, including universities, hospitals, R&D services, professional and technical services, management services, civic and professional organizations, grant making organizations, warehousing and storage, and air transportation. This cluster, which employed 32.5 million U.S. workers and paid out roughly $346.1 billion in payroll in the 2nd quarter of 2004, constitutes a large share of the growing professional services, education and hospital sectors. It is one of the few of the 45 clusters to post net job gains between 2nd quarters 2001 and 2004; it grew at a modest 0.6 percent annual rate over the period.

Other large U.S. clusters are closely related, including business services (23.9 million workers in IIQ '04), basic health services (21.6 million workers), hotels and transportation services (20.0 million workers), financial services and insurance (15.1 million workers), information services (12.4 million workers), and arts and media (11.4 million workers). With the exception of basic health services, employment declined in each of these clusters between IIQ '01 and IIQ '04.[7]

The U.S. clusters posting the highest average wages–all over $50,000 per year–include aerospace, computer and electronic equipment, pharmaceuticals, petroleum and

gas, tobacco products, plastics and rubber manufacturing, precision instruments, information services, mining, chemical-based products, printing and publishing, motor vehicles, and steel milling. Average wages are lowest in the farming ($21,618), feed products ($26,501), textiles and apparel ($31,171), wood processing ($31,275), wood products and furniture ($31,517), and packaged food products clusters ($32,793). The average annual wage for all cluster industries in IIQ '04 was $43,498.

Derivation of technology-based cluster benchmarks

To develop a reduced set of technology-based cluster benchmarks, the 463 x 463 share matrix, $\mathbf{R}^{\mathbf{MAX}}$, was reduced to a 111 by 111 matrix of technology-intensive industries, $\mathbf{R}_{\mathbf{T}}^{\mathbf{MAX}}$. The 111 technology industries, which are listed in Table 5, were identified from two sources: the American Electronics Association and Hecker (1999). Ward's algorithm was applied to $\mathbf{R}_{\mathbf{T}}^{\mathbf{MAX}}$ and the 15-cluster solution was selected after closely examining all splits between 5 and 20 clusters. Secondary sectors were then added to the 15 core sector groupings where $z_{ik} > 1.80$. The lower z threshold of 1.80 was adopted after a z threshold of 2.25 admitted very few secondary sectors. The full set of technology-based cluster benchmarks is provided in Appendix Table 2.[8]

U.S. technology-based value chain cluster trends

Table 6 reports some basic trends by technology cluster. The largest technology-based clusters are technical and research services (4.3 million employees in IIQ 2004) and architectural and engineering services (3.5 million workers). There is, however, considerable overlap between those two clusters. Other large technology value chain clusters include information services (employing some 3 million workers), wiring devices and switches (1.5 million workers), engine equipment (1.1 million workers), and computer and electronic equipment (1.0 million workers), and motor vehicles (990 thousand workers).

The technology sector was hit especially hard during the 2000/2001 recession, as is reflected in the cluster trends. Both the computer and electronics cluster and cable manufacturing clusters suffered the largest relative job losses as demand for computers

and networking equipment and infrastructure fell dramatically. No technology cluster posted net job gains between IIQ 2001 and IIQ 2004.

Payroll data suggest the strongest technology sectors in the most recent period have been health-related. Pharmaceuticals cluster payroll grew at a 3.2 percent annual rate between IIQ 2001 and IIQ 2004 while medical instruments and optics payrolls expanded slightly. Wiring devices and switches also posted solid payroll gains.

Reference

[1] See http://data.isc.hbs.edu/isc/index.jsp.

[2] Because the methodological approach is not the same as that used by Feser and Bergman (2000) to develop the 1987 benchmark manufacturing clusters or by Feser and Koo (2000) to develop an updated set of 1992 benchmark clusters, the new benchmark clusters is not strictly comparable with those earlier sets.

[3] An Excel file with the full cluster definitions is available from the author. It includes datasets structured in a form useful for direct match-merging with NAICS-based economic data (2002 or 1997 NAICS).

[4] Bergman et al. (1996) solved this problem by limiting their analysis to the manufacturing sector alone. Feser and Koo (2000) included non-manufacturing in their set of revised value chains but only by using a combination of input-output and occupational employment data to analyze linkages in non-manufacturing sectors relatively independently from the analysis of linkages in manufacturing. Simple data reduction analysis applied to the full set of manufacturing and non-manufacturing industries in the U.S. transactions table typically yields very broad and internally heterogeneous clusters as large purchases by many industries to a few producer services sectors drive the commonalities.

[5] 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.

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

[7] Note that while the farming cluster is comprised of the farming, fishing and fertilizer industries based on trading patterns revealed in the input-output data, it is not well represented in the employment and wage data provided in Table 4. *Quarterly Census of Employment and Wages* data exclude many farm workers.

[8] The *z* score values are provided in Appendix Table 2 so that users can select a higher threshold for secondary sector inclusion if they wish.

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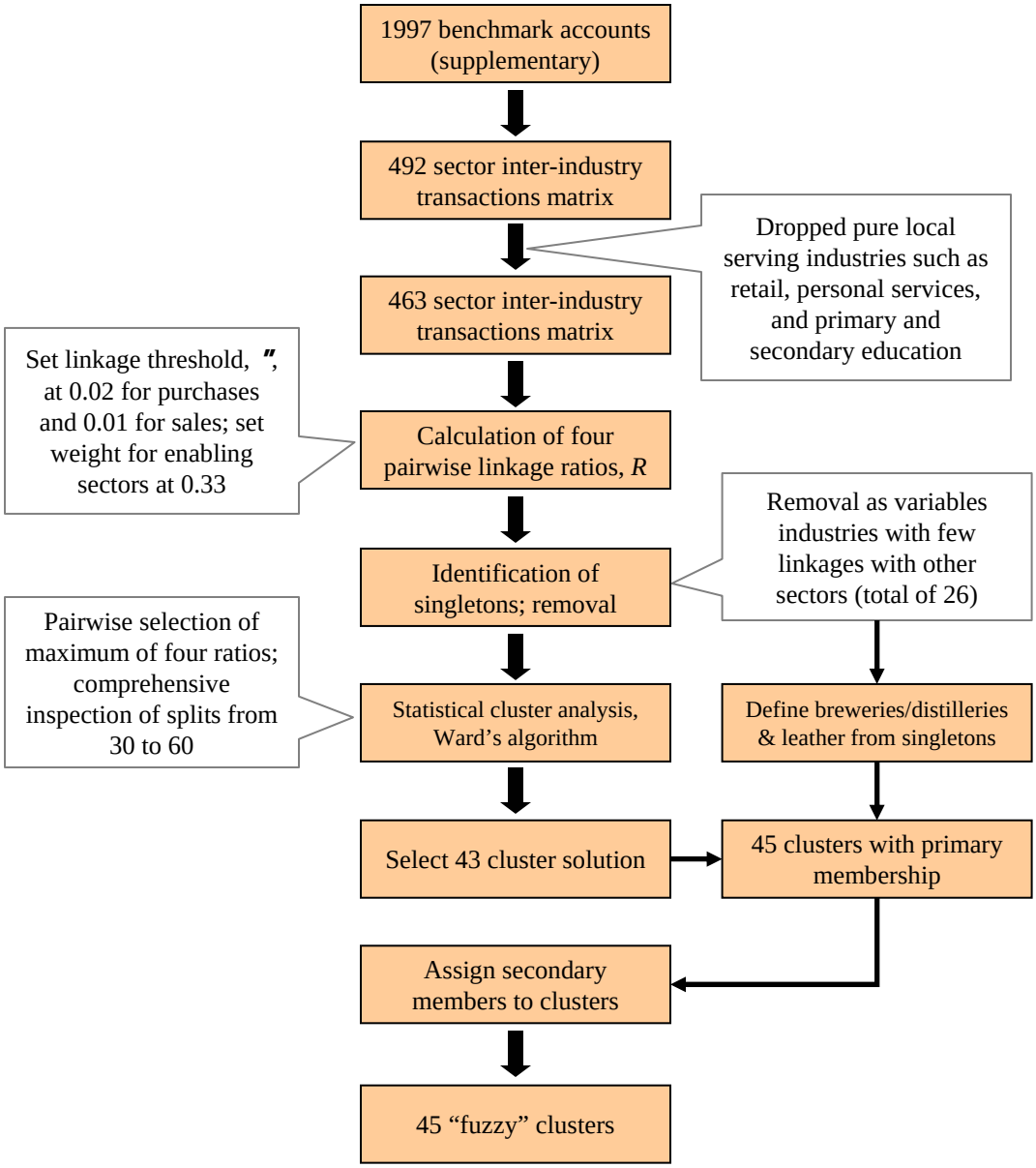

Figure 1. Benchmark cluster methodology

Table 1

Sectors excluded from analysis

NAICS	Sector
491000	Postal service
4A0000	Retail trade
532100	Automotive equipment rental and leasing
532230	Video tape and disc rental
532A00	General and consumer goods rental except video tapes and discs
611100	Elementary and secondary schools
624400	Child day care services
624A00	Social assistance, except child day care services
713940	Fitness and recreational sports centers
713950	Bowling centers
722000	Food services and drinking places
811192	Car washes
8111A0	Automotive repair and maintenance, except car washes
811400	Household goods repair and maintenance
812100	Personal care services
812200	Death care services
812300	Drycleaning and laundry services
812900	Other personal services
813100	Religious organizations
S00101	Federal electric utilities
S00102	Other Federal Government enterprises
S00201	State and local government passenger transit
S00202	State and local government electric utilities
S00203	Other State and local government enterprises
S00500	General government industry
S00800	Owner-occupied dwellings

Table 2

Producer services (or "enabling") industries

IO Code	Sector	IO Code	Sector
420000	Wholesale trade	531000	Real estate
481000	Air transportation	532400	Machinery and equipment rental and leasing
482000	Rail transportation	533000	Lessors of nonfinancial intangible assets
483000	Water transportation	541100	Legal services
484000	Truck transportation	541200	Accounting and bookkeeping services
485000	Transit and ground passenger transportation	541300	Architectural and engineering services
486000	Pipeline transportation	541400	Specialized design services
48A000	Scenic and sightseeing transportation and support activities for transportation	541511	Custom computer programming services
492000	Couriers and messengers	541512	Computer systems design services
493000	Warehousing and storage	54151A	Other computer related services, including facilities management
511110	Newspaper publishers	541610	Management consulting services
511120	Periodical publishers	5416A0	Environmental and other technical consulting services
511130	Book publishers	541700	Scientific research and development services
5111A0	Database, directory, and other publishers	541800	Advertising and related services
511200	Software publishers	541920	Photographic services
512100	Motion picture and video industries	541940	Veterinary services
512200	Sound recording industries	5419A0	All other miscellaneous professional and technical services
513100	Radio and television broadcasting	550000	Management of companies and enterprises
513200	Cable networks and program distribution	561300	Employment services
513300	Telecommunications	561500	Travel arrangement and reservation services
514100	Information services	561100	Office administrative services
514200	Data processing services	561200	Facilities support services
52A000	Monetary authorities and depository credit intermediation	561400	Business support services
522A00	Nondepository credit intermediation and related activities	561600	Investigation and security services
523000	Securities, commodity contracts, investments	561700	Services to buildings and dwellings
524100	Insurance carriers	561900	Other support services
524200	Insurance agencies, brokerages, and related	562000	Waste management and remediation services
525000	Funds, trusts, and other financial vehicles		

Sectors are suppliers to many industries and therefore receive a lower weight in the calculation of the pairwise linkage measures.

Table 3

Singleton sectors (linkages with few industries)

NAICS	Sector
112300	Poultry and egg production
113300	Logging
114100	Fishing
114200	Hunting and trapping
213112	Support activities for oil and gas operations
221300	Water, sewage and other systems
230210	Manufacturing and industrial buildings
230240	Water, sewer, and pipeline construction
230330	Maintenance and repair of highways, streets, bridges, and tunnels
311223	Other oilseed processing
311700	Seafood product preparation and packaging
312120	Breweries
312130	Wineries
312140	Distilleries
316100	Leather and hide tanning and finishing
316200	Footwear manufacturing
316900	Other leather product manufacturing
321991	Manufactured home, mobile home, manufacturing
324191	Petroleum lubricating oil and grease manufacturing
335110	Electric lamp bulb and part manufacturing
33641A	Propulsion units and parts for space vehicles and guided missiles
336612	Boat building
336999	All other transportation equipment manufacturing
337121	Upholstered household furniture manufacturing
337920	Blind and shade manufacturing
339116	Dental laboratories
339910	Jewelry and silverware manufacturing
339950	Sign manufacturing
482000	Rail transportation
483000	Water transportation
533000	Lessors of nonfinancial intangible assets
811300	Commercial machinery repair and maintenance

Table 4

U.S. summary, benchmark value chain clusters

	Employment			Quarterly Payroll (2nd Q)			
Clusters	2004 (000's)	% all sectors 2004	CAGR '01-'04	2004 (Mil $)	% all sectors 2004	CAGR '01-'04	Average Wage 2004
Textiles & apparel	877.8	0.68	-9.2	6,840.2	0.55	-4.9	31,171
Packaged food products	1,290.8	0.99	-1.6	10,582.1	0.86	1.0	32,793
Plastics & rubber manufacturing	637.5	0.49	-4.9	9,639.1	0.78	-1.6	60,477
Aluminum & aluminum products	660.7	0.51	-5.0	7,660.2	0.62	-2.1	46,374
Basic health services	21,556.1	16.60	0.7	232,354.4	18.82	3.2	43,116
Mining	342.3	0.26	-0.9	4,413.0	0.36	1.4	51,572
Farming	739.2	0.57	0.3	3,994.9	0.32	2.8	21,618
Construction	7,209.6	5.55	0.4	69,867.4	5.66	2.0	38,764
Financial services & insurance	15,070.5	11.61	-0.1	183,144.9	14.84	3.0	48,610
Chemical-based products	465.6	0.36	-5.3	7,009.5	0.57	-2.6	60,222
Machine tools	1,056.5	0.81	-5.1	10,968.4	0.89	-2.5	41,529
Precision instruments	407.7	0.31	-6.8	5,748.4	0.47	-3.9	56,398
Printing & publishing	2,525.7	1.95	-3.0	31,616.6	2.56	-1.0	50,071
Metalworking & fab metal products	661.8	0.51	-4.0	6,411.6	0.52	-1.1	38,755
Dairy products	369.5	0.28	-0.9	3,036.4	0.25	1.1	32,873
Nondurable industry machinery	1,602.0	1.23	-4.8	19,453.2	1.58	-1.4	48,573
Computer & electronic equipment	1,377.5	1.06	-9.2	23,366.2	1.89	-6.4	67,851
Wood products & furniture	635.9	0.49	-4.1	5,010.8	0.41	-0.9	31,517
Constr machinery & distribution equip	599.5	0.46	-6.3	7,268.1	0.59	-3.0	48,497
Wood processing	841.2	0.65	-2.1	6,577.3	0.53	1.1	31,275
Paper	548.7	0.42	-4.9	6,059.7	0.49	-1.2	44,173
Concrete, brick building products	876.2	0.67	-0.7	7,997.6	0.65	2.1	36,512
Motor vehicles	1,261.8	0.97	-3.0	16,385.1	1.33	0.5	51,943
Wood building products	947.3	0.73	-1.4	8,536.3	0.69	1.2	36,044
Plastics products	793.2	0.61	-3.9	8,172.3	0.66	-0.6	41,211
Feed products	877.6	0.68	-1.1	5,814.2	0.47	2.0	26,501
Arts, media & recreation	11,369.2	8.76	-0.8	126,456.6	10.25	0.7	44,491
Research, higher education & hospitals	32,477.6	25.01	0.6	346,193.2	28.05	3.6	42,638
Information services	12,401.4	9.55	-2.0	165,551.2	13.41	-0.8	53,398
Petroleum & gas	1,651.1	1.27	-1.3	25,725.7	2.08	1.3	62,324
Business services	23,930.5	18.43	-0.3	270,209.0	21.89	2.0	45,166
Grain milling	88.9	0.07	-1.1	830.2	0.07	2.2	37,340
Rubber products	524.6	0.40	-5.5	5,714.7	0.46	-2.6	43,576
Glass products	353.0	0.27	-5.5	3,447.4	0.28	-2.8	39,064
Pharmaceuticals	533.9	0.41	-1.2	8,445.2	0.68	2.3	63,267
Steel milling	193.2	0.15	-6.1	2,526.2	0.20	-2.0	52,300
Nonresidential building products	2,319.1	1.79	-1.5	28,843.2	2.34	1.6	49,750
Tobacco products	31.3	0.02	-3.2	441.3	0.04	-5.5	56,305
Optical Equipment & Instruments	449.2	0.35	-4.2	5,539.1	0.45	-0.1	49,323
Appliances	1,069.2	0.82	-2.4	10,011.6	0.81	0.6	37,455
Copper & copper products	218.5	0.17	-6.4	2,335.1	0.19	-4.2	42,747
Hotels & transportation services	20,041.4	15.43	-0.2	186,039.5	15.07	2.5	37,131
Aerospace	586.2	0.45	-3.8	10,183.8	0.83	0.2	69,487
Breweries & distilleries	343.7	0.26	-2.3	3,676.7	0.30	1.3	42,794
Leather products	154.5	0.12	-7.2	1,368.8	0.11	-1.9	35,446
Total, All Covered Establishments	129,854.7	100.00	-0.1	1,234,295.7	100.00	2.4	38,021
Total, VC Cluster Industries	83,078.8	63.98	-0.8	903,437.0	73.19	1.7	43,498

Source: Data are 2nd quarter figures from the US Bureau of Labor Statistics, Quarterly Census of Employment and Wages. Clusters are not mutually exclusive. CAGR: Compound annual growth rate. Sectors not assigned to any cluster include federal, state and local government; the US Postal Service; retail trade; basic consumer services; social services and religious organizations; and household employees.

Table 5

Technology-based industries

IO Code	Sector	IO Code	Sector
325110	Petrochemical manufacturing	334210	Telephone apparatus manufacturing
325120	Industrial gas manufacturing	334220	Broadcast and wireless communications equipment
325130	Synthetic dye and pigment manufacturing	334290	Other communications equipment manufacturing
325180	Other basic inorganic chemical manufacturing	334300	Audio and video equipment manufacturing
325190	Other basic organic chemical manufacturing	334411	Electron tube manufacturing
325211	Plastics material and resin manufacturing	334413	Semiconductors and related device manufacturing
325212	Synthetic rubber manufacturing	33441A	All other electronic component manufacturing
325221	Cellulosic organic fiber manufacturing	334510	Electromedical apparatus manufacturing
325222	Noncellulosic organic fiber manufacturing	334511	Search, detection, and navigation instruments
325311	Nitrogenous fertilizer manufacturing	334512	Automatic environmental control manufacturing
325312	Phosphatic fertilizer manufacturing	334513	Industrial process variable instruments
325314	Fertilizer, mixing only, manufacturing	334514	Totalizing fluid meters and counting devices
325320	Pesticide and other agricultural chemical manufacturing	334515	Electricity and signal testing instruments
325400	Pharmaceutical and medicine manufacturing	334516	Analytical laboratory instrument manufacturing
325510	Paint and coating manufacturing	334517	Irradiation apparatus manufacturing
325520	Adhesive manufacturing	33451A	Watch, clock, and other measuring and controlling device manufacturing
325611	Soap and other detergent manufacturing	335311	Electric power and specialty transformer manufacturing
325612	Polish and other sanitation good manufacturing	335312	Motor and generator manufacturing
325613	Surface active agent manufacturing	335313	Switchgear and switchboard apparatus manufacturing
325620	Toilet preparation manufacturing	335314	Relay and industrial control manufacturing
325910	Printing ink manufacturing	335911	Storage battery manufacturing
325920	Explosives manufacturing	335912	Primary battery manufacturing
325991	Custom compounding of purchased resins	335921	Fiber optic cable manufacturing
325992	Photographic film and chemical manufacturing	335929	Other communication and energy wire manufacturing
325998	Other miscellaneous chemical product manufacturing	335930	Wiring device manufacturing
332910	Metal valve manufacturing	335991	Carbon and graphite product manufacturing
332994	Small arms manufacturing	335999	Miscellaneous electrical equipment manufacturing
332995	Other ordnance and accessories manufacturing	336110	Automobile and light truck manufacturing
33299A	Ammunition manufacturing	336120	Heavy duty truck manufacturing
333120	Construction machinery manufacturing	336300	Motor vehicle parts manufacturing
333131	Mining machinery and equipment manufacturing	336411	Aircraft manufacturing
333132	Oil and gas field machinery and equipment	336412	Aircraft engine and engine parts manufacturing
333295	Semiconductor machinery manufacturing	336413	Other aircraft parts and equipment
333314	Optical instrument and lens manufacturing	336414	Guided missile and space vehicle manufacturing
333315	Photographic and photocopying equipment manufacturing	33641A	Propulsion units and parts for space vehicles and guided missiles
333611	Turbine and turbine generator set units manufacturing	336500	Railroad rolling stock manufacturing
333618	Other engine equipment manufacturing	336992	Military armored vehicles and tank parts manufacturing
33361A	Speed changers and mechanical power transmission equipment	339112	Surgical and medical instrument manufacturing
333911	Pump and pumping equipment manufacturing	339113	Surgical appliance and supplies manufacturing
333912	Air and gas compressor manufacturing	339114	Dental equipment and supplies manufacturing
333913	Measuring and dispensing pump manufacturing	339115	Ophthalmic goods manufacturing
333921	Elevator and moving stairway manufacturing	511200	Software publishers
333922	Conveyor and conveying equipment manufacturing	513200	Cable networks and program distribution
333923	Overhead cranes, hoists, and monorail systems	513300	Telecommunications
333924	Industrial truck, trailer, and stacker manufacturing	514100	Information services
333991	Power-driven handtool manufacturing	514200	Data processing services
333992	Welding and soldering equipment manufacturing	541300	Architectural and engineering services
333993	Packaging machinery manufacturing	541400	Specialized design services
333994	Industrial process furnace and oven manufacturing	541511	Custom computer programming services
333995	Fluid power cylinder and actuator manufacturing	541512	Computer systems design services
333996	Fluid power pump and motor manufacturing	54151A	Other computer related services, including facilities management
33399A	Scales, balances, and miscellaneous general purpose machinery	541610	Management consulting services
334111	Electronic computer manufacturing	5416A0	Environmental and other technical consulting services
334112	Computer storage device manufacturing	541700	Scientific research and development services
334113	Computer terminal manufacturing	621B00	Other ambulatory health care services
334119	Other computer peripheral equipment manufacturing		

Table 6

U.S. summary, benchmark technology-based value chain clusters

	Employment			Quarterly Payroll (2nd Q)			
Clusters	2004 (000's)	% all sectors 2004	CAGR '01-'04	2004 (Mil $)	% all sectors 2004	CAGR '01-'04	Average Wage 2004
Chemicals	305.1	0.23	-4.6	4,705.1	0.38	-1.4	61,686
Precision instruments	280.8	0.22	-6.6	4,135.7	0.34	-4.3	58,913
Engine equipment	1,113.5	0.86	-4.5	13,782.4	1.12	-0.8	49,512
Computer & electronic equip	1,041.1	0.80	-10.5	18,965.2	1.54	-7.3	72,868
Information services	2,960.9	2.28	-6.2	50,780.7	4.11	-5.7	68,602
Pharmaceuticals	414.2	0.32	-0.4	6,939.9	0.56	3.2	67,021
Fertilizer & chemical-based products	153.6	0.12	-4.6	2,500.4	0.20	-2.5	65,095
Industrial machinery & distr equip	284.2	0.22	-7.3	3,695.1	0.30	-4.0	51,999
Aerospace	438.4	0.34	-4.9	7,373.2	0.60	-0.7	67,272
Medical instruments & optics	404.3	0.31	-4.4	5,349.3	0.43	0.1	52,928
Motor vehicles	989.2	0.76	-3.7	13,719.4	1.11	0.1	55,479
Wiring devices & switches	1,476.4	1.14	-1.4	20,944.2	1.70	1.7	56,744
Technical & research services	4,347.3	3.35	-0.3	64,931.0	5.26	1.1	59,744
Cable manufacturing	154.5	0.12	-8.6	1,814.1	0.15	-5.6	46,966
Architectural & engineering services	3,537.2	2.72	-1.3	57,181.7	4.63	0.3	64,664
Total, All Covered Establishments	129,854.7	100.00	-0.1	1,234,295.7	100.00	2.4	38,021
Total, VC Cluster Industries	83,078.8	63.98	-0.8	903,437.0	73.19	1.7	43,498

Source: Data are 2nd quarter figures from the US Bureau of Labor Statistics, Quarterly Census of Employment and Wages. Clusters are not mutually exclusive. CAGR: Compound annual growth rate. Sectors not assigned to any cluster include federal, state and local government; the US Postal Service; retail trade; basic consumer services; social services and religious organizations; and household employees.

Appendix Table 1

1997 Benchmark Value Chain Clusters (NAICS Basis)

Based on the *Benchmark Input-Output Accounts of the United States, 1997*

Variable definitions:	
ID Code	A unique ID assigned to each (1,. . .15) identified cluster
Cluster Descriptor	Unique descriptor attached to each cluster based on interpretation of membership
IO Code	Input-output classification code, *Benchmark Input-Output Accounts of the United States, 1997*
Primary Cluster ID	Indicates value chain cluster in which row sector is a *primary member*
IO Sector Label	Descriptive sector label
Primary Member Indicator	1 if row sector is a primary member of given value chain cluster (useful for sorting)
Secondary Member Indicator	1 if row sector is a secondary member of a given value chain cluster (useful for sorting)
Linkage Measure	A measure of the strength of the row sector's linkage to overall value chain cluster (higher value indicates stronger linkage)
Z-Score	Linkage measure specified as Z-score (secondary sectors identified as non-primary sectors with Z greater than or equal to 2.25)

ID Code	Cluster Descriptor	IO Code	IO Sector Label	Primary Cluster ID	Primary Member Indicator	Secondary Member Indicator	Linkage Measure	Z-Score
1	**Textiles & apparel**	I313240	Knit fabric mills	1	1	0	0.45138	4.90
1		I313220	Narrow fabric mills & schiffli embroidery	1	1	0	0.43659	4.68
1		I315119	Other hosiery & sock mills	1	1	0	0.42976	4.57
1		I315111	Sheer hosiery mills	1	1	0	0.42316	4.47
1		I313210	Broadwoven fabric mills	1	1	0	0.42229	4.46
1		I31499A	Other misc textile product mills	1	1	0	0.41113	4.29
1		I313310	Textile & fabric finishing mills	1	1	0	0.41016	4.27
1		I313230	Nonwoven fabric mills	1	1	0	0.40421	4.18
1		I314110	Carpet & rug mills	1	1	0	0.40179	4.14
1		I314120	Curtain & linen mills	1	1	0	0.40176	4.14
1		I313100	Fiber, yarn, & thread mills	1	1	0	0.39424	4.03
1		I313320	Fabric coating mills	1	1	0	0.37316	3.71
1		I315190	Other apparel knitting mills	1	1	0	0.36436	3.57
1		I314910	Textile bag & canvas mills	1	1	0	0.36140	3.53
1		I315200	Cut & sew apparel manf	1	1	0	0.36125	3.52
1		I315900	Accessories & other apparel manf	1	1	0	0.35784	3.47
1		I314992	Tire cord & tire fabric mills	1	1	0	0.30891	2.72
1		I337910	Mattress manf	1	1	0	0.29260	2.47
1		I327910	Abrasive product manf	1	1	0	0.27939	2.27
1		I325221	Cellulosic organic fiber manf	3	0	1	0.31457	2.81
1		I325222	Noncellulosic organic fiber manf	3	0	1	0.30243	2.62
1		I337121	Upholstered household furniture manufacturing	0	0	1	0.22525	1.44
2	**Packaged food products**	I311813	Frozen cakes & other pastries manf	2	1	0	0.42555	4.63
2		I311410	Frozen food manf	2	1	0	0.42279	4.59
2		I311941	Mayonnaise, dressing, & sauce manf	2	1	0	0.40388	4.29
2		I311420	Fruit & vegetable canning & drying	2	1	0	0.37659	3.87
2		I311822	Mixes & dough made from purchased flour	2	1	0	0.37611	3.86
2		I31181A	Bread & bakery product, except frozen, manf	2	1	0	0.37449	3.83
2		I311821	Cookie & cracker manf	2	1	0	0.37441	3.83
2		I311230	Breakfast cereal manf	2	1	0	0.37440	3.83
2		I311830	Tortilla manf	2	1	0	0.36617	3.70
2		I311340	Nonchocolate confectionery manf	2	1	0	0.35076	3.46
2		I311990	All other food manf	2	1	0	0.34316	3.34
2		I311823	Dry pasta manf	2	1	0	0.34215	3.33
2		I311615	Poultry processing	2	1	0	0.33252	3.18
2		I311330	Confectionery manf from purchased chocolate	2	1	0	0.32311	3.03
2		I311612	Meat processed from carcasses	2	1	0	0.32271	3.02
2		I311942	Spice & extract manf	2	1	0	0.32047	2.99
2		I312110	Soft drink & ice manf	2	1	0	0.31649	2.93
2		I311320	Confectionery manf from cacao beans	2	1	0	0.31486	2.90
2		I311919	Other snack food manf	2	1	0	0.31066	2.83
2		I311930	Flavoring syrup & concentrate manf	2	1	0	0.29270	2.55
2		I311611	Animal, except poultry, slaughtering	2	1	0	0.27562	2.29
2		I311225	Fats & oils refining & blending	2	1	0	0.27561	2.29
2		I311920	Coffee & tea manf	2	1	0	0.27282	2.24
2		I311911	Roasted nuts & peanut butter manf	2	1	0	0.26880	2.18
3	**Plastics & rubber manufacturing**	I325110	Petrochemical manf	3	1	0	0.61273	5.07
3		I325212	Synthetic rubber manf	3	1	0	0.61043	5.05
3		I325190	Other basic organic chemical manf	3	1	0	0.60517	4.99
3		I325211	Plastics material & resin manf	3	1	0	0.60183	4.95
3		I325222	Noncellulosic organic fiber manf	3	1	0	0.56941	4.59
3		I325520	Adhesive manf	3	1	0	0.52435	4.08
3		I325613	Surface active agent manf	3	1	0	0.51578	3.98
3		I325998	Other misc chemical product manf	3	1	0	0.51087	3.93
3		I325221	Cellulosic organic fiber manf	3	1	0	0.50963	3.91
3		I325320	Pesticide & other agricultural chemical manf	3	1	0	0.48696	3.66
3		I325991	Custom compounding of purchased resins	25	0	1	0.43828	3.11
3		I325130	Synthetic dye & pigment manf	10	0	1	0.39440	2.62
3		I325611	Soap & other detergent manf	35	0	1	0.38587	2.52
3		I3221A0	Paper & paperboard mills	10	0	1	0.38496	2.51
3		I325311	Nitrogenous fertilizer manf	30	0	1	0.38185	2.48
3		I324110	Petroleum refineries	30	0	1	0.37527	2.40
3		I326120	Plastics pipe, fittings, & profile shapes	25	0	1	0.37055	2.35
3		I326160	Plastics bottle manf	25	0	1	0.36679	2.31
4	**Aluminum & aluminum products**	I331315	Aluminum sheet, plate, & foil manf	4	1	0	0.46121	5.55
4		I331314	Secondary smelting & alloying of aluminum	4	1	0	0.45699	5.48
4		I331316	Aluminum extruded product manf	4	1	0	0.44564	5.29
4		I331319	Other aluminum rolling & drawing	4	1	0	0.43052	5.04
4		I331312	Primary aluminum production	4	1	0	0.41819	4.84
4		I33152A	Aluminum foundries	4	1	0	0.40906	4.69
4		I33152B	Nonferrous foundries, except aluminum	4	1	0	0.38222	4.24
4		I331510	Ferrous metal foundaries	4	1	0	0.33825	3.51
4		I332112	Nonferrous forging	4	1	0	0.32637	3.31
4		I331112	Ferroalloy & related product manf	4	1	0	0.30004	2.88
4		I336611	Ship building & repairing	4	1	0	0.23563	1.81
4		I332430	Metal can, box, & other container manf	14	0	1	0.30627	2.98
4		I331419	Primary nonferrous metal, except copper & aluminum	41	0	1	0.29921	2.86
4		I331492	Secondary processing of other nonferrous	41	0	1	0.29575	2.81
4		I331421	Copper rolling, drawing, & extruding	41	0	1	0.28080	2.56
4		I332322	Sheet metal work manf	14	0	1	0.26778	2.34
4		I331111	Iron & steel mills	36	0	1	0.26356	2.27
4		I337920	Blind and shade manufacturing	0	0	1	0.17870	0.87
5	**Basic health services**	I621A00	Offices of physicians, dentists, & other health practioners	5	1	0	0.68034	5.25
5		I621B00	Other ambulatory health care svcs	5	1	0	0.68034	5.25
5		I561100	Office administrative svcs	5	1	0	0.67740	5.22
5		I561300	Employment svcs	5	1	0	0.67740	5.22
5		I561200	Facilities support svcs	5	1	0	0.66078	5.06
5		I621600	Home health care svcs	5	1	0	0.61004	4.57
5		I541100	Legal svcs	31	0	1	0.48473	3.35
5		I334510	Electromedical apparatus manf	17	0	1	0.45462	3.06
5		I325400	Pharmaceutical & medicine manf	35	0	1	0.44628	2.98
5		I339112	Surgical & medical instrument manf	39	0	1	0.44306	2.94
5		I561700	Services to buildings & dwellings	42	0	1	0.42351	2.75
5		I541200	Accounting & bookkeeping svcs	31	0	1	0.39760	2.50
5		I541610	mgmt consulting svcs	31	0	1	0.39707	2.50

ID Code	Cluster Descriptor	IO Code	IO Sector Label	Primary Cluster ID	Primary Member Indicator	Secondary Member Indicator	Linkage Measure	Z-Score
5		I339113	Surgical appliance & supplies manf	39	0	1	0.39471	2.47
5		I5416A0	Environmental & other technical consulting svcs	31	0	1	0.39463	2.47
5		I541300	Architectural & engineering svcs	31	0	1	0.37831	2.31
5		I420000	Wholesale trade	31	0	1	0.37828	2.31
5		I561400	Business support svcs	31	0	1	0.37250	2.26
6	**Mining**	I2122A0	Gold, silver, & other metal ore mining	6	1	0	0.54590	6.55
6		I212310	Stone mining & quarrying	6	1	0	0.53744	6.42
6		I212230	Copper, nickel, lead, & zinc mining	6	1	0	0.53401	6.36
6		I212210	Iron ore mining	6	1	0	0.53058	6.31
6		I212100	Coal mining	6	1	0	0.51442	6.05
6		I212320	Sand, gravel, clay, & refractory mining	6	1	0	0.46456	5.25
6		I212390	Other nonmetallic mineral mining	6	1	0	0.45905	5.17
6		I21311A	Support activities for other mining	6	1	0	0.44447	4.93
6		I213112	Support activities for oil & gas operations	0	0	1	0.33579	3.20
6		I482000	Rail transportation	0	0	1	0.25322	1.88
7	**Farming**	I1111B0	Grain farming	7	1	0	0.61296	6.04
7		I111335	Tree nut farming	7	1	0	0.59141	5.77
7		I1119A0	Sugarcane & sugar beet farming	7	1	0	0.59078	5.76
7		I111200	Vegetable & melon farming	7	1	0	0.57465	5.56
7		I1111A0	Oilseed farming	7	1	0	0.57407	5.55
7		I1113A0	Fruit farming	7	1	0	0.56695	5.46
7		I1119B0	All other crop farming	7	1	0	0.55223	5.28
7		I111400	Greenhouse & nursery production	7	1	0	0.54998	5.25
7		I111920	Cotton farming	7	1	0	0.52529	4.94
7		I111910	Tobacco farming	7	1	0	0.48580	4.45
7		I112100	Cattle ranching & farming	26	0	1	0.35341	2.79
7		I325312	Phosphatic fertilizer manf	10	0	1	0.32754	2.46
7		I114100	Fishing	0	0	1	0.14561	0.18
8	**Construction**	I230140	New farm housing units & additions & alterations	8	1	0	0.53067	6.43
8		I230130	New residential additions & alterations, nonfarm	8	1	0	0.51124	6.14
8		I230110	New residential 1-unit structures, nonfarm	8	1	0	0.50277	6.01
8		I230310	Maintenance & repair of farm & nonfarm residential structures	8	1	0	0.49387	5.88
8		I230120	New multifamily housing structures, nonfarm	8	1	0	0.48110	5.69
8		I230220	Commercial & institutional buildings	8	1	0	0.44740	5.18
8		I230340	Other maintenance & repair construction	8	1	0	0.41823	4.74
8		I230250	Other new construction	8	1	0	0.41202	4.65
8		I230230	Highway, street, bridge, & tunnel construction	8	1	0	0.37193	4.05
8		I230320	Maintenance & repair of nonresidential buildings	42	0	1	0.47331	5.57
8		I230330	Maintenance & repair of highways, streets, bridges, & tunnels	0	0	1	0.30654	3.07
8		I230210	Manufacturing & industrial buildings	0	0	1	0.29935	2.96
8		I230240	Water, sewer, & pipeline construction	0	0	1	0.28767	2.78
8		I321992	Prefabricated wood building manf	24	0	1	0.27031	2.52
8		I321991	Manufactured home, mobile home, manf	0	0	1	0.25547	2.30
9	**Financial services & insurance**	I525000	Funds, trusts, & other financial vehicles	9	1	0	0.64340	7.19
9		I524200	Insurance agencies, brokerages, & related	9	1	0	0.57201	6.28
9		I524100	Insurance carriers	9	1	0	0.56822	6.23
9		I523000	Securities, commodity contracts, investments	9	1	0	0.56344	6.17
9		I52A000	Monetary authorities & depository credit intermediation	31	0	1	0.45131	4.74
9		I541200	Accounting & bookkeeping svcs	31	0	1	0.37025	3.71
9		I541610	mgmt consulting svcs	31	0	1	0.36373	3.63
9		I541100	Legal svcs	31	0	1	0.34728	3.42
9		I522A00	Nondepository credit intermediation & related activities	31	0	1	0.33959	3.32
9		I561300	Employment svcs	5	0	1	0.33267	3.23
9		I541300	Architectural & engineering svcs	31	0	1	0.30533	2.88
9		I541800	Advertising & related svcs	31	0	1	0.27497	2.50
9		I532400	Machinery & equip rental & leasing	31	0	1	0.26954	2.43
9		I561400	Business support svcs	31	0	1	0.26697	2.39
9		I492000	Couriers & messengers	42	0	1	0.25995	2.30
9		I533000	Lessors of nonfinancial intangible assets	0	0	1	0.13687	0.74
10	**Chemical-based products**	I3221A0	Paper & paperboard mills	10	1	0	0.35682	3.44
10		I325312	Phosphatic fertilizer manf	10	1	0	0.35227	3.36
10		I32712A	Clay refractory & other structural clay products	10	1	0	0.33900	3.15
10		I322110	Pulp mills	10	1	0	0.33648	3.10
10		I331311	Alumina refining	10	1	0	0.33329	3.05
10		I335991	Carbon & graphite product manf	10	1	0	0.33311	3.05
10		I325130	Synthetic dye & pigment manf	10	1	0	0.32958	2.99
10		I325180	Other basic inorganic chemical manf	10	1	0	0.31980	2.83
10		I321219	Reconstituted wood product manf	10	1	0	0.30988	2.67
10		I327125	Nonclay refractory manf	10	1	0	0.30413	2.57
10		I325920	Explosives manf	10	1	0	0.30102	2.52
10		I325120	Industrial gas manf	10	1	0	0.29726	2.46
10		I327993	Mineral wool manf	10	1	0	0.29677	2.45
10		I325314	Fertilizer, mixing only, manf	10	1	0	0.28052	2.19
10		I311613	Rendering & meat byproduct processing	10	1	0	0.25495	1.76
10		I325110	Petrochemical manf	3	0	1	0.31625	2.77
10		I327121	Brick & structural clay tile manf	22	0	1	0.31222	2.71
10		I325190	Other basic organic chemical manf	3	0	1	0.30786	2.63
10		I325311	Nitrogenous fertilizer manf	30	0	1	0.30776	2.63
10		I325221	Cellulosic organic fiber manf	3	0	1	0.30274	2.55
10		I325212	Synthetic rubber manf	3	0	1	0.30154	2.53
10		I325222	Noncellulosic organic fiber manf	3	0	1	0.29309	2.39
11	**Machine tools**	I33361A	Speed changers & mechanical power transmission equip	11	1	0	0.46334	3.53
11		I333511	Industrial mold manf	11	1	0	0.46076	3.50
11		I333514	Special tool, die, jig, & fixture manf	11	1	0	0.45305	3.41
11		I332710	Machine shops	11	1	0	0.44998	3.37
11		I333515	Cutting tool & machine tool accessory manf	11	1	0	0.44415	3.31
11		I333995	Fluid power cylinder & actuator manf	11	1	0	0.44111	3.27
11		I332600	Spring & wire product manf	11	1	0	0.43464	3.19
11		I332991	Ball & roller bearing manf	11	1	0	0.42755	3.11
11		I333412	Industrial & commercial fan & blower manf	11	1	0	0.41114	2.92
11		I332720	Turned product & screw, nut, & bolt manf	11	1	0	0.40782	2.88
11		I333513	Metal forming machine tool manf	11	1	0	0.40272	2.82
11		I332111	Iron & steel forging	11	1	0	0.39902	2.77
11		I332999	misc fabricated metal product manf	11	1	0	0.39841	2.77
11		I332212	Hand & edge tool manf	11	1	0	0.39821	2.77
11		I332994	Small arms manf	11	1	0	0.39173	2.69
11		I33211A	All other forging & stamping	11	1	0	0.39071	2.68
11		I332213	Saw blade & handsaw manf	11	1	0	0.37811	2.53
11		I336992	Military armored vehicles & tank parts manf	11	1	0	0.37222	2.46
11		I333996	Fluid power pump & motor manf	11	1	0	0.36654	2.39
11		I333411	Air purification equip manf	11	1	0	0.35910	2.31
11		I332997	Industrial pattern manf	11	1	0	0.35366	2.24
11		I332910	Metal valve manf	11	1	0	0.34539	2.14
11		I339995	Burial casket manf	11	1	0	0.33248	1.99
11		I332500	Hardware manf	40	0	1	0.38412	2.60
11		I333414	Heating equip, except warm air furnaces	40	0	1	0.36063	2.32
12	**Precision instruments**	I334513	Industrial process variable instruments	12	1	0	0.45943	4.44
12		I334512	Automatic environmental control manf	12	1	0	0.45591	4.39
12		I334516	Analytical laboratory instrument manf	12	1	0	0.45277	4.35

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12		I33451A	Watch, clock, & other measuring & controlling device manf	12	1	0	0.44312	4.21
12		I333314	Optical instrument & lens manf	12	1	0	0.42726	3.99
12		I339111	Laboratory apparatus & furniture manf	12	1	0	0.40941	3.74
12		I334514	Totalizing fluid meters & counting devices	12	1	0	0.40670	3.70
12		I334300	Audio & video equip manf	12	1	0	0.33280	2.66
12		I335224	Household laundry equip manf	12	1	0	0.33114	2.64
12		I335222	Household refrigerator & home freezer manf	12	1	0	0.33035	2.62
12		I333315	Photographic & photocopying equip manf	12	1	0	0.30313	2.24
12		I334515	Electricity & signal testing instruments	17	0	1	0.38156	3.35
12		I335211	Electric housewares & household fan manf	40	0	1	0.34251	2.80
12		I335228	Other major household appliance manf	40	0	1	0.34058	2.77
12		I335314	Relay & industrial control manf	16	0	1	0.31329	2.38
13	**Printing & publishing**	I511120	Periodical publishers	13	1	0	0.59569	6.05
13		I511110	Newpaper publishers	13	1	0	0.58962	5.97
13		I5111A0	Database, directory, & other publishers	13	1	0	0.58419	5.90
13		I323117	Books printing	13	1	0	0.53421	5.22
13		I323122	Prepress svcs	13	1	0	0.52978	5.16
13		I32311A	Commercial printing	13	1	0	0.52599	5.11
13		I511130	Book publishers	13	1	0	0.51602	4.97
13		I541800	Advertising & related svcs	31	0	1	0.37326	3.04
13		I541610	mgmt consulting svcs	31	0	1	0.34600	2.67
13		I513200	Cable networks & program distribution	27	0	1	0.32001	2.31
13		I339950	Sign manufacturing	0	0	1	0.24474	1.29
14	**Metalworking & fabricated metal products**	I332323	Ornamental & architectural metal work manf	14	1	0	0.55930	4.36
14		I332322	Sheet metal work manf	14	1	0	0.55032	4.27
14		I332313	Plate work manf	14	1	0	0.55012	4.26
14		I332410	Power boiler & heat exchanger manf	14	1	0	0.53929	4.15
14		I332420	Metal tank, heavy gauge, manf	14	1	0	0.52651	4.01
14		I332311	Prefabricated metal buildings & components	14	1	0	0.51484	3.88
14		I332312	Fabricated structural metal manf	14	1	0	0.49706	3.68
14		I332114	Custom roll forming	14	1	0	0.49357	3.64
14		I332321	Metal window & door manf	14	1	0	0.48621	3.56
14		I332430	Metal can, box, & other container manf	14	1	0	0.45109	3.18
14		I332996	Fabricated pipe & pipe fitting manf	14	1	0	0.44850	3.15
14		I331222	Steel wire drawing	14	1	0	0.38811	2.49
14		I33211A	All other forging & stamping	11	0	1	0.44743	3.14
14		I332999	misc fabricated metal product manf	11	0	1	0.37862	2.39
14		I333412	Industrial & commercial fan & blower manf	11	0	1	0.37309	2.33
15	**Dairy products**	I311512	Creamery butter manf	15	1	0	0.78468	8.66
15		I311511	Fluid milk manf	15	1	0	0.75057	8.23
15		I311520	Ice cream & frozen dessert manf	15	1	0	0.71027	7.71
15		I311514	Dry, condensed, & evaporated dairy products	15	1	0	0.69449	7.51
15		I311513	Cheese manf	15	1	0	0.61986	6.56
15		I112100	Cattle ranching & farming	26	0	1	0.37645	3.45
15		I311320	Confectionery manf from cacao beans	2	0	1	0.32409	2.78
15		I311821	Cookie & cracker manf	2	0	1	0.29889	2.46
15		I311330	Confectionery manf from purchased chocolate	2	0	1	0.28550	2.29
15		I311700	Seafood product preparation and packaging	0	0	1	0.19162	1.09
16	**Nondurable industry machinery**	I333293	Printing machinery & equip manf	16	1	0	0.41630	3.20
16		I333292	Textile machinery manf	16	1	0	0.41475	3.18
16		I333294	Food product machinery manf	16	1	0	0.41428	3.18
16		I333912	Air & gas compressor manf	16	1	0	0.41106	3.14
16		I333220	Plastics & rubber industry machinery	16	1	0	0.40919	3.11
16		I333911	Pump & pumping equip manf	16	1	0	0.40369	3.05

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16		I333298	All other industrial machinery manf	16	1	0	0.39847	2.99
16		I333618	Other engine equip manf	16	1	0	0.38447	2.82
16		I33399A	Scales, balances, & misc general purpose machinery	16	1	0	0.38444	2.82
16		I333210	Sawmill & woodworking machinery	16	1	0	0.37373	2.69
16		I333611	Turbine & turbine generator set units manf	16	1	0	0.37329	2.68
16		I333319	Other commercial & service industry machinery manf	16	1	0	0.36918	2.64
16		I335312	Motor & generator manf	16	1	0	0.36220	2.55
16		I33331A	Automatic vending, commercial laundry & drycleaning machinery	16	1	0	0.35261	2.44
16		I333991	Power-driven handtool manf	16	1	0	0.34563	2.35
16		I333295	Semiconductor machinery manf	16	1	0	0.33243	2.20
16		I336300	Motor vehicle parts manf	16	1	0	0.32584	2.12
16		I333992	Welding & soldering equip manf	16	1	0	0.31327	1.97
16		I335314	Relay & industrial control manf	16	1	0	0.30287	1.84
16		I333913	Measuring & dispensing pump manf	40	0	1	0.36923	2.64
16		I333922	Conveyor & conveying equip manf	19	0	1	0.36359	2.57
16		I333513	Metal forming machine tool manf	11	0	1	0.36196	2.55
16		I33351A	Rolling mill & other metalworking machinery	19	0	1	0.36174	2.55
16		I333291	Paper industry machinery manf	19	0	1	0.35440	2.46
16		I333996	Fluid power pump & motor manf	11	0	1	0.35396	2.45
16		I333415	AC, refrigeration, & forced air heating	40	0	1	0.34423	2.34
16		I333923	Overhead cranes, hoists, & monorail systems	19	0	1	0.34014	2.29
16		I333414	Heating equip, except warm air furnaces	40	0	1	0.33865	2.27
16		I333120	Construction machinery manf	19	0	1	0.33787	2.26
16		I811300	Commercial machinery repair and maintenance	0	0	1	0.23335	1.01
17	**Computer & electronic equipment**	I334119	Other computer peripheral equip manf	17	1	0	0.48462	4.85
17		I334112	Computer storage device manf	17	1	0	0.47753	4.76
17		I33441A	All other electronic component manf	17	1	0	0.46439	4.57
17		I334515	Electricity & signal testing instruments	17	1	0	0.44580	4.32
17		I334220	Broadcast & wireless communications equip	17	1	0	0.44376	4.29
17		I334511	Search, detection, & navigation instruments	17	1	0	0.42836	4.08
17		I333313	Office machinery manf	17	1	0	0.41931	3.95
17		I334113	Computer terminal manf	17	1	0	0.41573	3.90
17		I334111	Electronic computer manf	17	1	0	0.41428	3.88
17		I334517	Irradiation apparatus manf	17	1	0	0.41267	3.86
17		I334210	Telephone apparatus manf	17	1	0	0.40304	3.73
17		I334413	Semiconductors & related device manf	17	1	0	0.39859	3.67
17		I334411	Electron tube manf	17	1	0	0.37484	3.34
17		I334510	Electromedical apparatus manf	17	1	0	0.35213	3.02
17		I334513	Industrial process variable instruments	12	0	1	0.36547	3.21
17		I334290	Other communications equip manf	37	0	1	0.34830	2.97
17		I334516	Analytical laboratory instrument manf	12	0	1	0.34206	2.89
17		I33451A	Watch, clock, & other measuring & controlling device manf	12	0	1	0.32455	2.64
17		I811200	Electronic equip repair & maintenance	29	0	1	0.31604	2.53
17		I335999	misc electrical equip manf	33	0	1	0.30751	2.41
17		I335314	Relay & industrial control manf	16	0	1	0.29746	2.27
18	**Wood products & furniture**	I337212	Custom architectural woodwork & millwork	18	1	0	0.60915	5.28
18		I337127	Institutional furniture manf	18	1	0	0.60017	5.17
18		I337211	Wood office furniture manf	18	1	0	0.58430	4.98
18		I337122	Nonupholstered wood household furniture manf	18	1	0	0.57011	4.81
18		I337215	Showcases, partitions, shelving, & lockers	18	1	0	0.54979	4.57
18		I337214	Office furniture, except wood, manf	18	1	0	0.54121	4.46
18		I337110	Wood kitchen cabinet & countertop manf	18	1	0	0.53816	4.43
18		I33712A	Other household & institutional furniture	18	1	0	0.50351	4.01
18		I337124	Metal household furniture manf	18	1	0	0.49318	3.89
18		I321999	misc wood product manf	20	0	1	0.44212	3.27
18		I321911	Wood windows & door manf	24	0	1	0.38603	2.60

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18		I339992	Musical instrument manf	39	0	1	0.36097	2.30
18		I337121	Upholstered household furniture manufacturing	0	0	1	0.24988	0.97
19	**Construction machinery & distribution equipment**	I333924	Industrial truck, trailer, & stacker manf	19	1	0	0.46000	4.03
19		I333922	Conveyor & conveying equip manf	19	1	0	0.44289	3.83
19		I333120	Construction machinery manf	19	1	0	0.42876	3.65
19		I33351A	Rolling mill & other metalworking machinery	19	1	0	0.42786	3.64
19		I333921	Elevator & moving stairway manf	19	1	0	0.41641	3.50
19		I333131	Mining machinery & equip manf	19	1	0	0.41396	3.48
19		I333111	Farm machinery & equip manf	19	1	0	0.40624	3.38
19		I333923	Overhead cranes, hoists, & monorail systems	19	1	0	0.39982	3.30
19		I333291	Paper industry machinery manf	19	1	0	0.39312	3.22
19		I333512	Metal cutting machine tool manf	19	1	0	0.37463	3.00
19		I333112	Lawn & garden equip manf	19	1	0	0.34562	2.65
19		I333132	Oil & gas field machinery & equip	19	1	0	0.34407	2.63
19		I333993	Packaging machinery manf	19	1	0	0.33438	2.51
19		I336500	Railroad rolling stock manf	19	1	0	0.33124	2.47
19		I333994	Industrial process furnace & oven manf	19	1	0	0.32484	2.40
19		I336991	Motorcycle, bicycle, & parts manf	19	1	0	0.29263	2.01
19		I335311	Electric power & specialty transformer manf	19	1	0	0.23899	1.36
19		I333513	Metal forming machine tool manf	11	0	1	0.38921	3.18
19		I333293	Printing machinery & equip manf	16	0	1	0.36998	2.94
19		I333292	Textile machinery manf	16	0	1	0.34720	2.67
19		I333210	Sawmill & woodworking machinery	16	0	1	0.34416	2.63
19		I333220	Plastics & rubber industry machinery	16	0	1	0.34319	2.62
19		I333611	Turbine & turbine generator set units manf	16	0	1	0.34127	2.60
19		I333618	Other engine equip manf	16	0	1	0.33697	2.54
19		I33361A	Speed changers & mechanical power transmission equip	11	0	1	0.33565	2.53
19		I333995	Fluid power cylinder & actuator manf	11	0	1	0.32040	2.34
19		I333294	Food product machinery manf	16	0	1	0.31595	2.29
20	**Wood processing**	I321912	Cut stock, resawing lumber, & planing	20	1	0	0.76815	7.52
20		I321920	Wood container & pallet manf	20	1	0	0.68400	6.50
20		I321113	Sawmills	20	1	0	0.66708	6.29
20		I321999	Misc wood product manf	20	1	0	0.61571	5.67
20		I32121A	Veneer & plywood manf	20	1	0	0.59200	5.38
20		I321918	Other millwork, including flooring	24	0	1	0.55630	4.95
20		I337110	Wood kitchen cabinet & countertop manf	18	0	1	0.46345	3.82
20		I321911	Wood windows & door manf	24	0	1	0.43061	3.42
20		I32121B	Engineered wood member & truss manf	24	0	1	0.41078	3.18
20		I321219	Reconstituted wood product manf	10	0	1	0.39127	2.94
20		I321114	Wood preservation	24	0	1	0.37535	2.75
20		I337122	Nonupholstered wood household furniture manf	18	0	1	0.35626	2.52
20		I337211	Wood office furniture manf	18	0	1	0.34945	2.44
20		I337212	Custom architectural woodwork & millwork	18	0	1	0.34508	2.38
20		I33712A	Other household & institutional furniture	18	0	1	0.34103	2.33
20		I113300	Logging	0	0	1	0.31945	2.07
21	**Paper**	I322232	Envelope manf	21	1	0	0.49270	5.29
21		I32222A	Coated & laminated paper & packaging materials	21	1	0	0.46127	4.81
21		I322210	Paperboard container manf	21	1	0	0.46108	4.81
21		I32222B	Coated & uncoated paper bag manf	21	1	0	0.44703	4.59
21		I322226	Surface-coated paperboard manufactuing	21	1	0	0.44131	4.50
21		I322231	Die-cut paper office supplies manf	21	1	0	0.42477	4.25
21		I322233	Stationery & related product manf	21	1	0	0.40643	3.97
21		I322299	All other converted paper product manf	21	1	0	0.37898	3.55
21		I323118	Blankbook & looseleaf binder manf	21	1	0	0.37550	3.49
21		I322291	Sanitary paper product manf	21	1	0	0.34672	3.05
21		I323116	Manifold business forms printing	21	1	0	0.34634	3.05
21		I325910	Printing ink manf	21	1	0	0.31452	2.56
21		I322225	Flexible packaging foil manf	21	1	0	0.30371	2.39
21		I326130	Laminated plastics plate, sheet, & shapes	25	0	1	0.33638	2.89
21		I326110	Plastics packaging materials, film & sheet	25	0	1	0.31914	2.63
21		I325992	Photographic film & chemical manf	39	0	1	0.30500	2.41
22	**Concrete, brick building products**	I327331	Concrete block & brick manf	22	1	0	0.57550	4.09
22		I327121	Brick & structural clay tile manf	22	1	0	0.57344	4.07
22		I327320	Ready-mix concrete manf	22	1	0	0.57082	4.04
22		I327122	Ceramic wall & floor tile manf	22	1	0	0.54473	3.78
22		I327420	Gypsum product manf	22	1	0	0.52697	3.60
22		I324121	Asphalt paving mixture & block manf	22	1	0	0.50532	3.38
22		I327310	Cement manf	22	1	0	0.49203	3.25
22		I326192	Resilient floor covering manf	22	1	0	0.47033	3.03
22		I327991	Cut stone & stone product manf	22	1	0	0.42517	2.58
22		I327410	Lime manf	22	1	0	0.39990	2.32
22		I321918	Other millwork, including flooring	24	0	1	0.54301	3.76
22		I321911	Wood windows & door manf	24	0	1	0.52294	3.56
22		I332321	Metal window & door manf	14	0	1	0.51993	3.53
22		I335211	Electric housewares & household fan manf	40	0	1	0.50448	3.37
22		I32121B	Engineered wood member & truss manf	24	0	1	0.49617	3.29
22		I337110	Wood kitchen cabinet & countertop manf	18	0	1	0.45996	2.93
22		I335228	Other major household appliance manf	40	0	1	0.45886	2.92
22		I333414	Heating equip, except warm air furnaces	40	0	1	0.45684	2.90
22		I321992	Prefabricated wood building manf	24	0	1	0.45274	2.85
22		I332998	Enameled iron & metal sanitary ware manf	40	0	1	0.42581	2.58
22		I332311	Prefabricated metal buildings & components	14	0	1	0.42485	2.57
22		I327332	Concrete pipe manf	37	0	1	0.42408	2.57
22		I335313	Switchgear & switchboard apparatus manf	40	0	1	0.40428	2.37
22		I337211	Wood office furniture manf	18	0	1	0.39614	2.28
22		I321114	Wood preservation	24	0	1	0.39389	2.26
23	**Motor vehicles**	I336120	Heavy duty truck manf	23	1	0	0.51318	6.65
23		I336211	Motor vehicle body manf	23	1	0	0.51100	6.62
23		I336212	Truck trailer manf	23	1	0	0.50285	6.48
23		I336110	Automobile & light truck manf	23	1	0	0.49863	6.41
23		I336213	Motor home manf	23	1	0	0.46566	5.86
23		I336214	Travel trailer & camper manf	23	1	0	0.44360	5.50
23		I336300	Motor vehicle parts manf	16	0	1	0.40194	4.81
23		I336991	Motorcycle, bicycle, & parts manf	19	0	1	0.34128	3.80
23		I336999	All other transport equip manf	0	0	1	0.29329	3.00
23		I336612	Boat building	0	0	1	0.27436	2.69
23		I334300	Audio & video equip manf	12	0	1	0.25887	2.43
23		I335110	Electric lamp bulb and part manufacturing	0	0	1	0.17931	1.11
24	**Wood building products**	I32121B	Engineered wood member & truss manf	24	1	0	0.72529	4.67
24		I321918	Other millwork, including flooring	24	1	0	0.70399	4.50
24		I321992	Prefabricated wood building manf	24	1	0	0.68367	4.34
24		I321911	Wood windows & door manf	24	1	0	0.67427	4.26
24		I321114	Wood preservation	24	1	0	0.62502	3.87
24		I332321	Metal window & door manf	14	0	1	0.62231	3.84
24		I327320	Ready-mix concrete manf	22	0	1	0.59099	3.59
24		I327331	Concrete block & brick manf	22	0	1	0.59099	3.59
24		I335211	Electric housewares & household fan manf	40	0	1	0.59099	3.59
24		I327121	Brick & structural clay tile manf	22	0	1	0.56712	3.40
24		I335313	Switchgear & switchboard apparatus manf	40	0	1	0.56240	3.36
24		I327420	Gypsum product manf	22	0	1	0.55785	3.33

ID Code	Cluster Descriptor	IO Code	IO Sector Label	Primary Cluster ID	Primary Member Indicator	Secondary Member Indicator	Linkage Measure	Z-Score
24		I333414	Heating equip, except warm air furnaces	40	0	1	0.55545	3.31
24		I327122	Ceramic wall & floor tile manf	22	0	1	0.54983	3.26
24		I335228	Other major household appliance manf	40	0	1	0.54798	3.25
24		I324121	Asphalt paving mixture & block manf	22	0	1	0.52005	3.02
24		I327332	Concrete pipe manf	37	0	1	0.48724	2.76
24		I332311	Prefabricated metal buildings & components	14	0	1	0.48286	2.72
24		I337110	Wood kitchen cabinet & countertop manf	18	0	1	0.48223	2.72
24		I326192	Resilient floor covering manf	22	0	1	0.46511	2.58
24		I321912	Cut stock, resawing lumber, & planing	20	0	1	0.45733	2.52
24		I335930	Wiring device manf	40	0	1	0.44654	2.43
24		I332998	Enameled iron & metal sanitary ware manf	40	0	1	0.44019	2.38
24		I332323	Ornamental & architectural metal work manf	14	0	1	0.43686	2.35
24		I321999	misc wood product manf	20	0	1	0.43150	2.31
25	**Plastics products**	I326120	Plastics pipe, fittings, & profile shapes	25	1	0	0.63911	5.65
25		I326110	Plastics packaging materials, film & sheet	25	1	0	0.63135	5.56
25		I32619A	Plastics plumbing fixtures & all other plastics products	25	1	0	0.57266	4.85
25		I326160	Plastics bottle manf	25	1	0	0.57135	4.84
25		I325991	Custom compounding of purchased resins	25	1	0	0.56397	4.75
25		I326130	Laminated plastics plate, sheet, & shapes	25	1	0	0.54147	4.48
25		I3261A0	Foam product manf	25	1	0	0.51518	4.16
25		I325222	Noncellulosic organic fiber manf	3	0	1	0.43236	3.17
25		I325221	Cellulosic organic fiber manf	3	0	1	0.40812	2.88
25		I325992	Photographic film & chemical manf	39	0	1	0.38228	2.57
25		I326192	Resilient floor covering manf	22	0	1	0.37904	2.53
25		I325212	Synthetic rubber manf	3	0	1	0.37564	2.49
25		I325211	Plastics material & resin manf	3	0	1	0.37015	2.42
26	**Feed products**	I311119	Other animal food manf	26	1	0	0.45450	6.23
26		I311111	Dog & cat food manf	26	1	0	0.44693	6.09
26		I311222	Soybean processing	26	1	0	0.42148	5.64
26		I112A00	Animal production, except cattle & poultry & eggs	26	1	0	0.40838	5.41
26		I112100	Cattle ranching & farming	26	1	0	0.40802	5.40
26		I113A00	Forest nurseries, forest products, & timber tracts	26	1	0	0.40580	5.36
26		I115000	Agriculture & forestry support activities	26	1	0	0.29904	3.47
26		I1111B0	Grain farming	7	0	1	0.34434	4.27
26		I112300	Poultry & egg production	0	0	1	0.27105	2.97
26		I1111A0	Oilseed farming	7	0	1	0.27038	2.96
26		I311212	Rice milling	32	0	1	0.26552	2.87
26		I111920	Cotton farming	7	0	1	0.26350	2.84
26		I1119B0	All other crop farming	7	0	1	0.25871	2.75
26		I333111	Farm machinery & equip manf	19	0	1	0.25376	2.66
26		I333924	Industrial truck, trailer, & stacker manf	19	0	1	0.25018	2.60
26		I325320	Pesticide & other agricultural chemical manf	3	0	1	0.23210	2.28
26		I311223	Other oilseed processing	0	0	1	0.21531	1.98
26		I114200	Hunting and trapping	0	0	1	0.21219	1.93
26		I311700	Seafood product preparation and packaging	0	0	1	0.16094	1.02
26		I114100	Fishing	0	0	1	0.11522	0.20
27	**Arts and media**	I711100	Performing arts companies	27	1	0	0.49374	5.42
27		I711A00	Promoters of performing arts & sports & agents for public figures	27	1	0	0.49033	5.37
27		I711500	Independent artists, writers, & performers	27	1	0	0.47640	5.17
27		I513100	Radio & television broadcasting	27	1	0	0.44132	4.68
27		I513200	Cable networks & program distribution	27	1	0	0.41724	4.34
27		I512100	Motion picture & video industries	27	1	0	0.40696	4.19
27		I711200	Spectator sports	27	1	0	0.40478	4.16
27		I541800	Advertising & related svcs	31	0	1	0.42898	4.50
27		I5419A0	All other misc professional & technical svcs	28	0	1	0.30410	2.73
27		I611B00	Other educational svcs	28	0	1	0.30263	2.71
27		I511110	Newpaper publishers	13	0	1	0.30202	2.70
27		I511120	Periodical publishers	13	0	1	0.29579	2.61
27		I713A00	Other amusement, gambling, & recreation industries	28	0	1	0.28912	2.52
27		I813B00	Civic, social, professional & similar organizations	28	0	1	0.28463	2.46
27		I512200	Sound recording industries	31	0	1	0.28189	2.42
27		I541200	Accounting & bookkeeping svcs	31	0	1	0.28088	2.40
27		I420000	Wholesale trade	31	0	1	0.27806	2.36
27		I514100	Information svcs	31	0	1	0.27392	2.30
27		I339950	Sign manufacturing	0	0	1	0.22359	1.59
28	**Higher education & hospitals**	I813B00	Civic, social, professional & similar organizations	28	1	0	0.43608	4.29
28		I611B00	Other educational svcs	28	1	0	0.42643	4.16
28		I5419A0	All other misc professional & technical svcs	28	1	0	0.41362	3.98
28		I712000	Museums, historical sites, zoos, & parks	28	1	0	0.37827	3.48
28		I541700	Scientific research & development svcs	28	1	0	0.37218	3.39
28		I611A00	Colleges, universities, & junior colleges	28	1	0	0.36829	3.34
28		I550000	Mgmt of companies & enterprises	28	1	0	0.35901	3.21
28		I713A00	Other amusement, gambling, & recreation industries	28	1	0	0.34934	3.07
28		I493000	Warehousing & storage	28	1	0	0.34727	3.04
28		I622000	Hospitals	28	1	0	0.33353	2.85
28		I623000	Nursing & residential care facilities	28	1	0	0.31402	2.57
28		I48A000	Scenic & sightseeing transport & support activities for transport	28	1	0	0.31244	2.55
28		I813A00	Grantmaking & giving & social advocacy organizations	28	1	0	0.30709	2.47
28		I541940	Veterinary svcs	28	1	0	0.27013	1.95
28		I481000	Air transport	28	1	0	0.26638	1.90
28		I561400	Business support svcs	31	0	1	0.36509	3.29
28		I420000	Wholesale trade	31	0	1	0.35564	3.16
28		I532400	Machinery & equip rental & leasing	31	0	1	0.35436	3.14
28		I5416A0	Environmental & other technical consulting svcs	31	0	1	0.35351	3.13
28		I561500	Travel arrangement & reservation svcs	31	0	1	0.35169	3.10
28		I7211A0	Hotels & motels, including casino hotels	42	0	1	0.35007	3.08
28		I561200	Facilities support svcs	5	0	1	0.32067	2.66
28		I541800	Advertising & related svcs	31	0	1	0.31145	2.53
28		I541610	mgmt consulting svcs	31	0	1	0.31006	2.51
28		I522A00	Nondepository credit intermediation & related activities	31	0	1	0.30571	2.45
28		I561900	Other support svcs	31	0	1	0.30419	2.43
28		I561100	Office administrative svcs	5	0	1	0.30154	2.39
28		I541200	Accounting & bookkeeping svcs	31	0	1	0.29955	2.37
28		I541100	Legal svcs	31	0	1	0.29473	2.30
29	**Information services**	I514200	Data processing svcs	29	1	0	0.58161	5.32
29		I54151A	Other computer related svcs, including facilities mgmt	29	1	0	0.58111	5.31
29		I541512	Computer systems design svcs	29	1	0	0.54878	4.91
29		I541511	Custom computer programming svcs	29	1	0	0.54160	4.82
29		I511200	Software publishers	29	1	0	0.53544	4.75
29		I811200	Electronic equip repair & maintenance	29	1	0	0.46182	3.84
29		I513300	Telecommunications	29	1	0	0.41462	3.26
29		I514100	Information svcs	31	0	1	0.42395	3.38
29		I420000	Wholesale trade	31	0	1	0.39538	3.03
29		I541200	Accounting & bookkeeping svcs	31	0	1	0.39387	3.01
29		I541800	Advertising & related svcs	31	0	1	0.39024	2.97
29		I561600	Investigation & security svcs	42	0	1	0.37782	2.81
29		I561100	Office administrative svcs	5	0	1	0.34750	2.44
29		I561500	Travel arrangement & reservation svcs	31	0	1	0.34746	2.44
29		I541920	Photographic svcs	31	0	1	0.34247	2.38
29		I541100	Legal svcs	31	0	1	0.34046	2.35

ID Code	Cluster Descriptor	IO Code	IO Sector Label	Primary Cluster ID	Primary Member Indicator	Secondary Member Indicator	Linkage Measure	Z-Score
30	**Petroleum & gas**	I486000	Pipeline transport	30	1	0	0.59307	6.17
30		I211000	Oil & gas extraction	30	1	0	0.57222	5.88
30		I324110	Petroleum refineries	30	1	0	0.53874	5.41
30		I325311	Nitrogenous fertilizer manf	30	1	0	0.50708	4.97
30		I324199	All other petroleum & coal products manf	30	1	0	0.48457	4.66
30		I213111	Drilling oil & gas wells	30	1	0	0.47145	4.48
30		I221100	Power generation & supply	30	1	0	0.46471	4.39
30		I221200	Natural gas distribution	30	1	0	0.45277	4.22
30		I562000	Waste mgmt & remediation svcs	30	1	0	0.37556	3.15
30		I325110	Petrochemical manf	3	0	1	0.38686	3.30
30		I324121	Asphalt paving mixture & block manf	22	0	1	0.37775	3.18
30		I325190	Other basic organic chemical manf	3	0	1	0.37091	3.08
30		I325211	Plastics material & resin manf	3	0	1	0.34588	2.74
30		I325120	Industrial gas manf	10	0	1	0.34281	2.69
30		I221300	Water, sewage and other systems	0	0	1	0.25196	1.43
31	**Business services**	I541200	Accounting & bookkeeping svcs	31	1	0	0.54071	4.14
31		I541800	Advertising & related svcs	31	1	0	0.49100	3.61
31		I541300	Architectural & engineering svcs	31	1	0	0.48856	3.58
31		I561400	Business support svcs	31	1	0	0.48852	3.58
31		I561500	Travel arrangement & reservation svcs	31	1	0	0.48790	3.58
31		I420000	Wholesale trade	31	1	0	0.48399	3.53
31		I541100	Legal svcs	31	1	0	0.48071	3.50
31		I541610	mgmt consulting svcs	31	1	0	0.48020	3.49
31		I532400	Machinery & equip rental & leasing	31	1	0	0.47825	3.47
31		I5416A0	Environmental & other technical consulting svcs	31	1	0	0.46722	3.36
31		I541920	Photographic svcs	31	1	0	0.46411	3.32
31		I561900	Other support svcs	31	1	0	0.46039	3.28
31		I514100	Information svcs	31	1	0	0.44571	3.13
31		I541400	Specialized design svcs	31	1	0	0.43882	3.05
31		I512200	Sound recording industries	31	1	0	0.41525	2.80
31		I522A00	Nondepository credit intermediation & related activities	31	1	0	0.41448	2.79
31		I52A000	Monetary authorities & depository credit intermediation	31	1	0	0.40530	2.70
31		I561100	Office administrative svcs	5	0	1	0.44786	3.15
31		I561200	Facilities support svcs	5	0	1	0.43066	2.97
31		I561300	Employment svcs	5	0	1	0.40595	2.70
31		I7211A0	Hotels & motels, including casino hotels	42	0	1	0.39886	2.63
31		I5419A0	All other misc professional & technical svcs	28	0	1	0.39860	2.63
31		I813B00	Civic, social, professional & similar organizations	28	0	1	0.38865	2.52
31		I561600	Investigation & security svcs	42	0	1	0.38235	2.45
31		I611B00	Other educational svcs	28	0	1	0.37758	2.40
31		I523000	Securities, commodity contracts, investments	9	0	1	0.37571	2.38
31		I541511	Custom computer programming svcs	29	0	1	0.37473	2.37
32	**Grain milling**	I311211	Flour milling	32	1	0	0.54754	6.23
32		I311213	Malt manf	32	1	0	0.54410	6.18
32		I311221	Wet corn milling	32	1	0	0.50509	5.59
32		I311212	Rice milling	32	1	0	0.50170	5.54
32		I311310	Sugar manf	32	1	0	0.48301	5.25
32		I112300	Poultry & egg production	0	0	1	0.30179	2.50
32		I312210	Tobacco stemming & redrying	38	0	1	0.28957	2.31
32		I311223	Other oilseed processing	0	0	1	0.26553	1.95
33	**Rubber products**	I326290	Other rubber product manf	33	1	0	0.36303	4.11
33		I326220	Rubber & plastics hose & belting manf	33	1	0	0.31947	3.25
33		I339991	Gasket, packing, & sealing device manf	33	1	0	0.31256	3.11
33		I33999A	Buttons, pins, & all other misc manf	33	1	0	0.30507	2.96
33		I335912	Primary battery manf	33	1	0	0.30346	2.93
33		I326210	Tire manf	33	1	0	0.30244	2.91
33		I33299A	Ammunition manf	33	1	0	0.29529	2.77
33		I335911	Storage battery manf	33	1	0	0.29001	2.66
33		I339114	Dental equip & supplies manf	33	1	0	0.28047	2.48
33		I332214	Kitchen utensil, pot, & pan manf	33	1	0	0.27311	2.33
33		I332995	Other ordnance & accessories manf	33	1	0	0.27262	2.32
33		I339920	Sporting & athletic goods manf	33	1	0	0.26522	2.17
33		I335999	misc electrical equip manf	33	1	0	0.24804	1.83
33		I335930	Wiring device manf	40	0	1	0.27611	2.39
33		I325992	Photographic film & chemical manf	39	0	1	0.27203	2.31
34	**Glass products**	I332813	Electroplating, anodizing, & coloring metal	34	1	0	0.41551	4.00
34		I327113	Porcelain electrical supply manf	34	1	0	0.41290	3.96
34		I327999	misc nonmetallic mineral products	34	1	0	0.40120	3.77
34		I327111	Vitreous china plumbing fixture manf	34	1	0	0.40018	3.75
34		I327213	Glass container manf	34	1	0	0.39443	3.66
34		I332812	Metal coating & nonprecious engraving	34	1	0	0.39031	3.60
34		I32721A	Glass & glass products, except glass containers	34	1	0	0.38440	3.50
34		I327112	Vitreous china & earthenware articles manf	34	1	0	0.38246	3.47
34		I332811	Metal heat treating	34	1	0	0.37697	3.38
34		I327992	Ground or treated minerals & earths manf	34	1	0	0.37397	3.33
34		I327122	Ceramic wall & floor tile manf	22	0	1	0.35758	3.07
34		I327121	Brick & structural clay tile manf	22	0	1	0.35599	3.05
34		I32712A	Clay refractory & other structural clay products	10	0	1	0.31935	2.46
34		I327310	Cement manf	22	0	1	0.31519	2.39
34		I327125	Nonclay refractory manf	10	0	1	0.31311	2.36
35	**Pharmaceuticals**	I325612	Polish & other sanitation good manf	35	1	0	0.65484	6.95
35		I325620	Toilet preparation manf	35	1	0	0.63403	6.66
35		I325611	Soap & other detergent manf	35	1	0	0.59478	6.12
35		I325400	Pharmaceutical & medicine manf	35	1	0	0.53544	5.29
35		I325320	Pesticide & other agricultural chemical manf	3	0	1	0.39450	3.33
35		I325520	Adhesive manf	3	0	1	0.35808	2.82
35		I325212	Synthetic rubber manf	3	0	1	0.34636	2.66
35		I325998	Other misc chemical product manf	3	0	1	0.33064	2.44
35		I339115	Ophthalmic goods manf	39	0	1	0.32843	2.41
35		I325613	Surface active agent manf	3	0	1	0.32219	2.32
35		I324191	Petroleum lubricating oil & grease manf	0	0	1	0.31911	2.28
36	**Steel milling**	I331111	Iron & steel mills	36	1	0	1.00000	9.28
36		I331210	Iron, steel pipe & tube from purchased steel	36	1	0	1.00000	9.28
36		I331221	Rolled steel shape manf	36	1	0	1.00000	9.28
36		I331222	Steel wire drawing	14	0	1	0.44844	3.30
36		I331112	Ferroalloy & related product manf	4	0	1	0.40746	2.86
36		I332311	Prefabricated metal buildings & components	14	0	1	0.38314	2.59
36		I331314	Secondary smelting & alloying of aluminum	4	0	1	0.35714	2.31
37	**Nonresidential building products**	I327332	Concrete pipe manf	37	1	0	0.44550	4.17
37		I327390	Other concrete product manf	37	1	0	0.42784	3.92
37		I334290	Other communications equip manf	37	1	0	0.38966	3.36
37		I324122	Asphalt shingle & coating materials manf	37	1	0	0.38377	3.27
37		I335921	Fiber optic cable manf	37	1	0	0.37750	3.18
37		I339994	Broom, brush, & mop manf	37	1	0	0.37553	3.15
37		I335929	Other communication & energy wire manf	37	1	0	0.35861	2.90
37		I325510	Paint & coating manf	37	1	0	0.32620	2.43
37		I327331	Concrete block & brick manf	22	0	1	0.40224	3.54
37		I327320	Ready-mix concrete manf	22	0	1	0.40013	3.51
37		I32121B	Engineered wood member & truss manf	24	0	1	0.39505	3.44

ID Code	Cluster Descriptor	IO Code	IO Sector Label	Primary Cluster ID	Primary Member Indicator	Secondary Member Indicator	Linkage Measure	Z-Score
37		I321114	Wood preservation	24	0	1	0.38991	3.36
37		I321992	Prefabricated wood building manf	24	0	1	0.38419	3.28
37		I321918	Other millwork, including flooring	24	0	1	0.37646	3.17
37		I324121	Asphalt paving mixture & block manf	22	0	1	0.37528	3.15
37		I335313	Switchgear & switchboard apparatus manf	40	0	1	0.36357	2.98
37		I335211	Electric housewares & household fan manf	40	0	1	0.36090	2.94
37		I541300	Architectural & engineering svcs	31	0	1	0.35935	2.92
37		I321911	Wood windows & door manf	24	0	1	0.35048	2.79
37		I332321	Metal window & door manf	14	0	1	0.34696	2.73
37		I327121	Brick & structural clay tile manf	22	0	1	0.34201	2.66
37		I332323	Ornamental & architectural metal work manf	14	0	1	0.34009	2.63
37		I327122	Ceramic wall & floor tile manf	22	0	1	0.33776	2.60
37		I335120	Lighting fixture manf	40	0	1	0.33487	2.56
37		I327420	Gypsum product manf	22	0	1	0.33343	2.54
37		I333414	Heating equip, except warm air furnaces	40	0	1	0.32788	2.46
37		I335930	Wiring device manf	40	0	1	0.32764	2.45
37		I332322	Sheet metal work manf	14	0	1	0.31690	2.30
38	**Tobacco products**	I312210	Tobacco stemming & redrying	38	1	0	1.00000	10.48
38		I312221	Cigarette manf	38	1	0	1.00000	10.48
38		I312229	Other tobacco product manf	38	1	0	1.00000	10.48
38		I111910	Tobacco farming	7	0	1	0.50000	4.43
39	**Optical Equipment & Instruments**	I339112	Surgical & medical instrument manf	39	1	0	0.44208	4.31
39		I334612	Audio & video media reproduction	39	1	0	0.41826	3.92
39		I339115	Ophthalmic goods manf	39	1	0	0.39442	3.54
39		I339930	Doll, toy, & game manf	39	1	0	0.39163	3.50
39		I325992	Photographic film & chemical manf	39	1	0	0.38622	3.41
39		I339113	Surgical appliance & supplies manf	39	1	0	0.38151	3.33
39		I339940	Office supplies, except paper, manf	39	1	0	0.38042	3.32
39		I332211	Cutlery & flatware, except precious, manf	39	1	0	0.37931	3.30
39		I334611	Software reproducing	39	1	0	0.34816	2.80
39		I334613	Magnetic & optical recording media manf	39	1	0	0.34790	2.79
39		I339992	Musical instrument manf	39	1	0	0.34685	2.78
39		I323121	Tradebinding & related work	39	1	0	0.34262	2.71
39		I326160	Plastics bottle manf	25	0	1	0.32600	2.44
39		I326130	Laminated plastics plate, sheet, & shapes	25	0	1	0.32582	2.44
40	**Appliances**	I335211	Electric housewares & household fan manf	40	1	0	0.50923	3.32
40		I333414	Heating equip, except warm air furnaces	40	1	0	0.49841	3.21
40		I332998	Enameled iron & metal sanitary ware manf	40	1	0	0.46256	2.85
40		I335228	Other major household appliance manf	40	1	0	0.45700	2.80
40		I335313	Switchgear & switchboard apparatus manf	40	1	0	0.44515	2.68
40		I335930	Wiring device manf	40	1	0	0.44400	2.67
40		I333415	AC, refrigeration, & forced air heating	40	1	0	0.42887	2.52
40		I332500	Hardware manf	40	1	0	0.42247	2.45
40		I335120	Lighting fixture manf	40	1	0	0.42197	2.45
40		I335221	Household cooking appliance manf	40	1	0	0.41177	2.34
40		I333913	Measuring & dispensing pump manf	40	1	0	0.41149	2.34
40		I335212	Household vacuum cleaner manf	40	1	0	0.40434	2.27
40		I321918	Other millwork, including flooring	24	0	1	0.47805	3.01
40		I332321	Metal window & door manf	14	0	1	0.46855	2.91
40		I321911	Wood windows & door manf	24	0	1	0.46754	2.90
40		I32121B	Engineered wood member & truss manf	24	0	1	0.45882	2.82
40		I327320	Ready-mix concrete manf	22	0	1	0.45176	2.75
40		I327331	Concrete block & brick manf	22	0	1	0.45176	2.75
40		I327420	Gypsum product manf	22	0	1	0.44745	2.70
40		I327121	Brick & structural clay tile manf	22	0	1	0.43573	2.58
40		I327122	Ceramic wall & floor tile manf	22	0	1	0.42324	2.46
40		I321992	Prefabricated wood building manf	24	0	1	0.41889	2.41
40		I332311	Prefabricated metal buildings & components	14	0	1	0.41833	2.41
40		I335224	Household laundry equip manf	12	0	1	0.40887	2.31
40		I337110	Wood kitchen cabinet & countertop manf	18	0	1	0.40562	2.28
40		I324121	Asphalt paving mixture & block manf	22	0	1	0.40434	2.27
41	**Copper & copper products**	I331421	Copper rolling, drawing, & extruding	41	1	0	0.58296	7.68
41		I331423	Secondary processing of copper	41	1	0	0.50354	6.38
41		I331411	Primary smelting & refining of copper	41	1	0	0.50320	6.37
41		I331419	Primary nonferrous metal, except copper & aluminum	41	1	0	0.49114	6.18
41		I331491	Nonferrous metal, except copper & aluminum, shaping	41	1	0	0.48506	6.08
41		I331422	Copper wire, except mechanical, drawing	41	1	0	0.45317	5.55
41		I331492	Secondary processing of other nonferrous	41	1	0	0.43299	5.22
41		I335929	Other communication & energy wire manf	37	0	1	0.32425	3.44
41		I331314	Secondary smelting & alloying of aluminum	4	0	1	0.32377	3.43
41		I331319	Other aluminum rolling & drawing	4	0	1	0.31612	3.30
41		I339910	Jewelry & silverware manf	0	0	1	0.27852	2.69
41		I331312	Primary aluminum production	4	0	1	0.25946	2.37
41		I335110	Electric lamp bulb and part manufacturing	0	0	1	0.20057	1.41
41		I339116	Dental laboratories	0	0	1	0.18538	1.16
42	**Hotels & transportation services**	I7211A0	Hotels & motels, including casino hotels	42	1	0	0.52466	4.95
42		I485000	Transit & ground passenger transport	42	1	0	0.50767	4.72
42		I230320	Maintenance & repair of nonresidential buildings	42	1	0	0.46204	4.11
42		I531000	Real estate	42	1	0	0.46016	4.09
42		I561600	Investigation & security svcs	42	1	0	0.45068	3.96
42		I561700	Services to buildings & dwellings	42	1	0	0.45037	3.96
42		I721A00	Other accommodations	42	1	0	0.41732	3.52
42		I492000	Couriers & messengers	42	1	0	0.41120	3.43
42		I484000	Truck transport	42	1	0	0.36114	2.77
42		I541200	Accounting & bookkeeping svcs	31	0	1	0.40333	3.33
42		I541100	Legal svcs	31	0	1	0.40197	3.31
42		I541610	Mgmt consulting svcs	31	0	1	0.38895	3.14
42		I561400	Business support svcs	31	0	1	0.38204	3.05
42		I561100	Office administrative svcs	5	0	1	0.37695	2.98
42		I52A000	Monetary authorities & depository credit intermediation	31	0	1	0.37604	2.96
42		I561300	Employment svcs	5	0	1	0.37547	2.96
42		I561200	Facilities support svcs	5	0	1	0.36492	2.82
42		I323118	Blankbook & looseleaf binder manf	21	0	1	0.34860	2.60
42		I5416A0	Environmental & other technical consulting svcs	31	0	1	0.33924	2.47
42		I522A00	Nondepository credit intermediation & related activities	31	0	1	0.33773	2.45
42		I481000	Air transport	28	0	1	0.32954	2.34
42		I322233	Stationery & related product manf	21	0	1	0.32893	2.34
42		I513300	Telecommunications	29	0	1	0.32634	2.30
43	**Aerospace**	I336411	Aircraft manf	43	1	0	0.67652	8.40
43		I336413	Other aircraft parts & equip	43	1	0	0.62643	7.63
43		I336412	Aircraft engine & engine parts manf	43	1	0	0.57332	6.82
43		I336414	Guided missile & space vehicle manf	43	1	0	0.46614	5.18
43		I33641A	Propulsion units & parts for space vehicles & guided missiles	0	0	1	0.39842	4.14
43		I334511	Search, detection, & navigation instruments	17	0	1	0.29543	2.57
44	**Breweries & Distilleries**	I312120	Breweries	44	1	0	0.75000	9.60
44		I312140	Distilleries	44	1	0	0.75000	9.60
44		I325620	Toilet preparation manufacturing	35	0	1	0.34940	3.28
44		I312130	Wineries	0	0	1	0.34441	3.20
44		I311420	Fruit and vegetable canning and drying	2	0	1	0.30522	2.59

ID Code	Cluster Descriptor	IO Code	IO Sector Label	Primary Cluster ID	Primary Member Indicator	Secondary Member Indicator	Linkage Measure	Z-Score
44		I312110	Soft drink and ice manufacturing	2	0	1	0.30272	2.55
44		I323117	Books printing	13	0	1	0.29131	2.37
45	**Leather Products**	I316900	Other leather product manufacturing	45	1	0	0.50257	8.20
45		I316200	Footwear manufacturing	45	1	0	0.48508	7.84
45		I316100	Leather and hide tanning and finishing	45	1	0	0.46854	7.49
45		I31499A	Other miscellaneous textile product mills	1	0	1	0.26667	3.24
45		I313320	Fabric coating mills	1	0	1	0.23776	2.63
45		I315900	Accessories and other apparel manufacturing	1	0	1	0.22792	2.42
45		I325221	Cellulosic organic fiber manufacturing	3	0	1	0.22336	2.33
45		I326220	Rubber and plastics hose and belting manufacturing	33	0	1	0.22220	2.30

Appendix Table 2

1997 Benchmark Value Chain Clusters (NAICS Basis), Technology Sectors

Based on the *Benchmark Input-Output Accounts of the United States, 1997*

Variable definitions:	
ID Code	A unique ID assigned to each (1,. . .45) identified cluster
Cluster Descriptor	Unique descriptor attached to each cluster based on interpretation of membership
IO Code	Input-output classification code, *Benchmark Input-Output Accounts of the United States, 1997*
Primary Cluster ID	Indicates value chain cluster in which row sector is a *primary member*
IO Sector Label	Descriptive sector label
Primary Member Indicator	1 if row sector is a primary member of given value chain cluster (useful for sorting)
Secondary Member Indicator	1 if row sector is a secondary member of a given value chain cluster (useful for sorting)
Linkage Measure	A measure of the strength of the row sector's linkage to overall value chain cluster (higher value indicates stronger linkage)
Z-Score	Linkage measure specified as Z-score (secondary sectors identified as non-primary sectors with Z greater than or equal to 2.25)

ID Code	Cluster Descriptor	IO Code	IO Sector Label	Primary Cluster ID	Primary Member Indicator	Secondary Member Indicator	Linkage Measure	Z-Score
1	**Chemicals**	I325110	Petrochemical manuf	1	1	0	0.57849	2.95
1		I325211	Plastics material & resin manuf	1	1	0	0.57411	2.92
1		I325190	Other basic organic chemical manuf	1	1	0	0.57017	2.89
1		I325212	Synthetic rubber manuf	1	1	0	0.56332	2.84
1		I325222	Noncellulosic organic fiber manuf	1	1	0	0.53847	2.65
1		I325520	Adhesive manuf	1	1	0	0.47510	2.18
1		I325613	Surface active agent manuf	1	1	0	0.47364	2.17
1		I325221	Cellulosic organic fiber manuf	1	1	0	0.46970	2.14
1		I325998	Other miscellaneous chemical product manuf	1	1	0	0.46431	2.10
1		I325991	Custom compounding of purchased resins	1	1	0	0.45873	2.05
1		I325320	Pesticide & other agricultural chemical manuf	1	1	0	0.44429	1.95
1		I325311	Nitrogenous fertilizer manuf	1	1	0	0.40785	1.67
1		I325910	Printing ink manuf	1	1	0	0.37651	1.44
2	**Precision Instruments**	I334513	Industrial process variable instruments	2	1	0	0.59886	3.60
2		I33451A	Watch, clock, & other measuring & controlling device manuf	2	1	0	0.57314	3.37
2		I334516	Analytical laboratory instrument manuf	2	1	0	0.56643	3.30
2		I334512	Automatic environmental control manuf	2	1	0	0.52874	2.95
2		I333314	Optical instrument & lens manuf	2	1	0	0.51836	2.86
2		I334514	Totalizing fluid meters & counting devices	2	1	0	0.50325	2.72
2		I335314	Relay & industrial control manuf	2	1	0	0.43730	2.10
2		I334515	Electricity & signal testing instruments	4	0	1	0.46302	2.34
3	**Engine Equipment**	I333996	Fluid power pump & motor manuf	3	1	0	0.43739	2.31
3		I33361A	Speed changers & mechanical power transmission equipment	3	1	0	0.43129	2.25
3		I333911	Pump & pumping equipment manuf	3	1	0	0.42838	2.23
3		I333912	Air & gas compressor manuf	3	1	0	0.42605	2.20
3		I333618	Other engine equipment manuf	3	1	0	0.42300	2.17
3		I332910	Metal valve manuf	3	1	0	0.41704	2.12
3		I333995	Fluid power cylinder & actuator manuf	3	1	0	0.41457	2.09
3		I333913	Measuring & dispensing pump manuf	3	1	0	0.40262	1.98
3		I333611	Turbine & turbine generator set units manuf	3	1	0	0.40247	1.98
3		I332994	Small arms manuf	3	1	0	0.40056	1.96
3		I33399A	Scales, balances, & miscellaneous general purpose machinery	3	1	0	0.39354	1.89
3		I333991	Power-driven handtool manuf	3	1	0	0.38320	1.79
3		I335312	Motor & generator manuf	3	1	0	0.36657	1.63
3		I336300	Motor vehicle parts manuf	3	1	0	0.35534	1.52
3		I333992	Welding & soldering equipment manuf	3	1	0	0.33151	1.29
3		I336992	Military armored vehicles & tank parts manuf	3	1	0	0.31744	1.16
4	**Computer & Electronic Equipment**	I334112	Computer storage device manuf	4	1	0	0.47813	2.64
4		I33441A	All other electronic component manuf	4	1	0	0.47717	2.63
4		I334119	Other computer peripheral equipment manuf	4	1	0	0.47664	2.62
4		I334220	Broadcast & wireless communications equipment	4	1	0	0.45730	2.44
4		I334515	Electricity & signal testing instruments	4	1	0	0.44930	2.37
4		I334511	Search, detection, & navigation instruments	4	1	0	0.43567	2.24
4		I334111	Electronic computer manuf	4	1	0	0.41690	2.06
4		I334210	Telephone apparatus manuf	4	1	0	0.41417	2.04
4		I334413	Semiconductors & related device manuf	4	1	0	0.41149	2.01
4		I334113	Computer terminal manuf	4	1	0	0.41140	2.01
4		I334517	Irradiation apparatus manuf	4	1	0	0.40980	2.00
4		I334411	Electron tube manuf	4	1	0	0.37559	1.68
4		I334510	Electromedical apparatus manuf	4	1	0	0.35180	1.46
5	**Information Services**	I514200	Data processing services	5	1	0	0.56672	3.66
5		I54151A	Other computer related services, including facilities management	5	1	0	0.54183	3.44
5		I541512	Computer systems design services	5	1	0	0.51757	3.21
5		I511200	Software publishers	5	1	0	0.51101	3.15
5		I541511	Custom computer programming services	5	1	0	0.50260	3.08
5		I514100	Information services	5	1	0	0.48647	2.93
5		I513300	Telecommunications	5	1	0	0.41961	2.32
5		I513200	Cable networks & program distribution	5	1	0	0.34928	1.67
6	**Pharmaceuticals**	I325612	Polish & other sanitation good manuf	6	1	0	0.65484	4.37
6		I325620	Toilet preparation manuf	6	1	0	0.63403	4.18
6		I325611	Soap & other detergent manuf	6	1	0	0.59478	3.81
6		I325400	Pharmaceutical & medicine manuf	6	1	0	0.53544	3.26
6		I325320	Pesticide & other agricultural chemical manuf	1	0	1	0.39450	1.95
7	**Fertilizer & Chemical Products**	I325312	Phosphatic fertilizer manuf	7	1	0	0.48985	3.68
7		I325314	Fertilizer, mixing only, manuf	7	1	0	0.42460	2.94
7		I325180	Other basic inorganic chemical manuf	7	1	0	0.40213	2.68
7		I325920	Explosives manuf	7	1	0	0.39712	2.62
7		I325130	Synthetic dye & pigment manuf	7	1	0	0.39703	2.62
7		I335991	Carbon & graphite product manuf	7	1	0	0.37261	2.34
7		I325120	Industrial gas manuf	7	1	0	0.36383	2.24
7		I325311	Nitrogenous fertilizer manuf	1	0	1	0.34172	1.99
7		I325110	Petrochemical manuf	1	0	1	0.33344	1.90
8	**Industrial Machinery & Distribution Equipment**	I333922	Conveyor & conveying equipment manuf	8	1	0	0.44636	2.70
8		I333924	Industrial truck, trailer, & stacker manuf	8	1	0	0.43525	2.59
8		I333131	Mining machinery & equipment manuf	8	1	0	0.43187	2.56
8		I333120	Construction machinery manuf	8	1	0	0.43127	2.55
8		I333921	Elevator & moving stairway manuf	8	1	0	0.41757	2.42
8		I333923	Overhead cranes, hoists, & monorail systems	8	1	0	0.41405	2.39
8		I333132	Oil & gas field machinery & equipment	8	1	0	0.35888	1.85
8		I333993	Packaging machinery manuf	8	1	0	0.35178	1.78
8		I333994	Industrial process furnace & oven manuf	8	1	0	0.34709	1.74
8		I336500	Railroad rolling stock manuf	8	1	0	0.34019	1.67
8		I333295	Semiconductor machinery manuf	8	1	0	0.29372	1.22
8		I335311	Electric power & specialty transformer manuf	8	1	0	0.26304	0.92
9	**Aerospace**	I336411	Aircraft manuf	9	1	0	0.61260	4.79
9		I336413	Other aircraft parts & equipment	9	1	0	0.57782	4.41
9		I33641A	Propulsion units & parts for space vehicles & guided missiles	9	1	0	0.51873	3.77

ID Code	Cluster Descriptor	IO Code	IO Sector Label	Primary Cluster ID	Primary Member Indicator	Secondary Member Indicator	Linkage Measure	Z-Score
9		I336412	Aircraft engine & engine parts manuf	9	1	0	0.50921	3.66
9		I336414	Guided missile & space vehicle manuf	9	1	0	0.49303	3.49
10	**Medical Instruments & Optics**	I339112	Surgical & medical instrument manuf	10	1	0	0.39194	3.22
10		I339115	Ophthalmic goods manuf	10	1	0	0.35493	2.62
10		I325992	Photographic film & chemical manuf	10	1	0	0.34741	2.50
10		I339113	Surgical appliance & supplies manuf	10	1	0	0.34288	2.42
10		I335912	Primary battery manuf	10	1	0	0.32538	2.14
10		I339114	Dental equipment & supplies manuf	10	1	0	0.31449	1.96
10		I335911	Storage battery manuf	10	1	0	0.31390	1.95
10		I332995	Other ordnance & accessories manuf	10	1	0	0.30112	1.74
10		I333315	Photographic & photocopying equipment manuf	10	1	0	0.30109	1.74
10		I334300	Audio & video equipment manuf	10	1	0	0.29539	1.65
10		I33299A	Ammunition manuf	10	1	0	0.28402	1.47
10		I335999	Miscellaneous electrical equipment manuf	10	1	0	0.27832	1.37
11	**Motor Vehicles**	I336110	Automobile & light truck manuf	11	1	0	0.78143	6.18
11		I336120	Heavy duty truck manuf	11	1	0	0.78143	6.18
11		I336300	Motor vehicle parts manuf	3	0	1	0.57214	4.18
11		I334300	Audio & video equipment manuf	10	0	1	0.32464	1.82
12	**Wiring Devices & Switches**	I335313	Switchgear & switchboard apparatus manuf	12	1	0	0.59969	3.82
12		I335930	Wiring device manuf	12	1	0	0.59439	3.77
12		I334290	Other communications equipment manuf	12	1	0	0.53509	3.16
12		I335312	Motor & generator manuf	3	0	1	0.45877	2.39
12		I541300	Architectural & engineering services	15	0	1	0.40546	1.85
13	**Technical & Research Services** *(Note high degree of overlap with cluster 15.)*	I5416A0	Environmental & other technical consulting services	13	1	0	0.54405	3.88
13		I541610	Management consulting services	13	1	0	0.51080	3.54
13		I541700	Scientific research & development services	13	1	0	0.49680	3.41
13		I541400	Specialized design services	13	1	0	0.49244	3.36
13		I621B00	Other ambulatory health care services	13	1	0	0.44944	2.93
13		I541300	Architectural & engineering services	15	0	1	0.43029	2.74
13		I541511	Custom computer programming services	5	0	1	0.35722	2.02
13		I514100	Information services	5	0	1	0.35111	1.96
14	**Cable manuf**	I335929	Other communication & energy wire manuf	14	1	0	0.55780	4.61
14		I335921	Fiber optic cable manuf	14	1	0	0.52820	4.27
14		I325510	Paint & coating manuf	14	1	0	0.47618	3.66
14		I335930	Wiring device manuf	12	0	1	0.37156	2.45
14		I335313	Switchgear & switchboard apparatus manuf	12	0	1	0.36799	2.41
15	**Architectural & Engineering Services** *(Note high degree of overlap with cluster 13.)*	I541300	Architectural & engineering services	15	1	0	1.00000	6.04
15		I334290	Other communications equipment manuf	12	0	1	0.53648	2.79
15		I5416A0	Environmental & other technical consulting services	13	0	1	0.52709	2.72
15		I541610	Management consulting services	13	0	1	0.48966	2.46
15		I541400	Specialized design services	13	0	1	0.44570	2.15
15		I514100	Information services	5	0	1	0.40988	1.90
15		I541511	Custom computer programming services	5	0	1	0.39920	1.82
15		I541700	Scientific research & development services	13	0	1	0.39920	1.82