An Evaluation of Competitive Industrial Structure and Regional Manufacturing Employment Change

(Regional Studies 2015, 49 (9): 1481-1496)

Joshua Drucker

University of Illinois at Chicago

Department of Urban Planning and Policy

412 South Peoria Street, Room 215, M/C 348

Chicago, Illinois 60607-7064

tel: 312-413-7597

fax: 312-413-2314

jdruck@uic.edu

Abstract

This paper examines the relationship between regional industrial structure and employment change in the manufacturing sector and 19 subsectors in the United States from 1987 to 1997. The relative associations of economic diversity, industrial specialization, and competitive structure with economic performance are assessed using a non-causal regression framework. Multiple facets of industrial structure at the regional scale, including competitive structure, are considered together by exploiting confidential microdata to construct and evaluate detailed metrics across broad geographic and industrial ranges. The findings suggest the importance of industrial competitive structure for understanding regional employment change, economic performance, and industrial development.

Disclaimer

Part of the research was conducted while the author was a Special Sworn Status researcher of the United States Census Bureau at the Triangle and Chicago Census Research Data Centers. The contents of this study have been screened to ensure that no confidential data are revealed. All contents and conclusions expressed are solely the responsibility of the author and do not necessarily reflect the views of any of the supporting organizations or the United States Census Bureau.

Keywords

industrial structure, diversity, manufacturing, competition, specialization, economic development

JEL codes

L11 Production, Pricing, and Market Structure; Size Distribution of Firms

O18 Urban, Rural, Regional, and Transportation Analysis; Housing; Infrastructure

R11 Regional Economic Activity: Growth, Development, and Changes

Introduction

A large and continually growing body of research focuses on the impacts of the spatial co-location of firms and industries on business performance through the creation of agglomeration economies. Although a reasonable consensus exists concerning the existence and gross scale of the net benefits of industrial agglomeration (STRANGE, 2009; PUGA, 2010), there is little clarity as to the specific nature (i.e., microlevel foundations) of the effects or the magnitude with which different sources of agglomeration externalities influence particular economic outcomes (PUGA, 2010; BOSCHMA and FRENKEN, 2011; NEFFKE et al., 2011). There are numerous reasons for this inconclusiveness, including differing foundational frameworks, the breadth of the geographic and temporal settings and the outcome variables investigated, varied methodologies, data limitations, and the difficulties inherent in distinguishing empirically among distinct sources of agglomeration economies (COMBES and OVERMAN, 2004). Another issue is that the particular sources or mechanisms that are examined differ from study to study (MELO et al., 2009). As a result, classifying and explaining the diverse, often contradictory, results obtained through empirical research is a far from straightforward task (see recent reviews by HANSON, 2001; ROSENTHAL and STRANGE, 2004; BEAUDRY and SCHIFFAUEROVA, 2009; DE GROOT et al., 2009; MELO et al., 2009). Burgeoning interest in evolutionary economics and economic geography has spurred new approaches including tying agglomeration effects to industrial life cycles and utilizing micro-level data to investigate characteristics at finer spatial and organizational resolutions (DURANTON and PUGA, 2001; ESSLETZBICHLER and RIGBY, 2007; BOSCHMA and FRENKEN, 2011).

This paper offers evidence on the influence of agglomerative traits of industries and regional economies on manufacturing employment growth in the United States. The purpose is to assess the relative effects of different features of localized industrial structure on performance. Non-causal regression analyses, based on micro-level data from the United States Census Bureau, provide information on the association of regional industrial competitive structure with change in manufacturing employment, in comparison to the distinct structural characteristics of industrial diversity and specialization.

The research contributes to and extends the literature in three ways. First, it adds to the growing but as yet inconclusive body of research examining the effects of regional industrial structure on employment change. Second, multiple indicators of industrial structure are considered together to compare sources of agglomeration externalities. The competitive aspect of industrial structure that is often overlooked may help explain why industries in regions that seem otherwise economically similar develop and evolve differently. Third, micro-level data covering the entire manufacturing sector across the contiguous United States permit quantitative analysis of more refined measures of regional industrial competitive structure and broader geographic coverage than has been feasible in previous research based on more coarse-grained sources of data.

Industrial Structure and Agglomeration Externalities

The empirical approach to regional industrial structure is rooted in the seminal articles by GLAESER et al., 1992, and HENDERSON et al., 1995, who link industrial employment growth to the extent of industrial diversity or specialization present in the local economy. Economic diversity is theorized to support overall resiliency with respect to sector-specific shocks or

temporary downturns (BREWER, 1985; FRENKEN et al., 2007), lower the odds of a sizable proportion of local employment being tied to an industry that is unstable or declining in the long term (MALIZIA and KE, 1993; DISSART, 2003), permit more diverse local inputs and services (SCOTT, 1988), and reduce frictional unemployment (IZRAELI and MURPHY, 2003; MIZUNO et al., 2006). Diversity may also enable cross-industry knowledge spillovers (sometimes termed "Jacobs" externalities, after JACOBS, 1969) with the potential to drive regional innovation and lead to economic dynamism (AUDRETSCH, 2003). On the other hand, the benefits of industrial specialization ("Marshallian" or "Marshall-Arrow-Romer" externalities) may include enhanced local supplies of specialized inputs, enlarged skilled labor pools yielding matching advantages for both employers and employees, facilitation of the local distribution of industry-specific knowledge and expertise, and advantages from shared public resources (HENDERSON, 1997; AUDRETSCH, 2003). GLAESER et al., 1992, HENDERSON et al., 1995, and many subsequent empirical works have generated evidence of a positive influence of diversity and/or specialization on economic performance, but have also exposed discrepancies (for the reasons mentioned earlier) that make further generalization difficult.

GLAESER et al., 1992, also consider the competitive structure of the local industry ("Porter" externalities). This feature has been examined repeatedly (though less often than diversity and specialization), typically gauged by average firm or plant size, with larger size indicating a more concentrated and less competitive local industry (BEAUDRY and SCHIFFAUEROVA, 2009). There are many explanations for how concentrated industrial structures may affect agglomeration benefits. Large firms are more likely to source inputs nonlocally, either through vertical integration or extra-regional contracts (ENRIGHT, 1995; PORTER, 1998; HENDERSON et al., 2001). If local suppliers do exist they may be allied to

large local manufacturers in order to obtain stable large-volume contracts, or may be more responsive to the needs of producers with the most buying power (NELSON and WINTER, 1982; BOOTH, 1986). Specialized labor pools may be curtailed, as workers with specialized training gravitate toward locally dominant, stable employers (AUDRETSCH, 2001), but *potential* job seekers are more likely to invest in obtaining industry-specific skills in the presence of rivalrous firms (PORTER, 1990). There may be less opportunity for interfirm networking and group learning in a regional environment dominated by one or a few large employers, decreasing knowledge spillovers and spin-off formation (SAXENIAN, 1994; CARREE and THURIK, 1999; MALMBERG and MASKELL, 2002). Concentrated industrial structures also may offer advantages. Large firms may act as regional anchors to attract specialized labor and intermediate suppliers, acclimate local government and financial communities to particular industry characteristics, and in the process benefit smaller firms in the industry (FELDMAN, 2003). Established firms generate knowledge and technology spillovers that can provide opportunities for fledgling enterprises (AGRAWAL and COCKBURN, 2003).

Empirical work generally suggests a positive relationship between smaller average firm or plant size and outcomes such as firm births, employment growth, entrepreneurship, and productive efficiency (e.g., COMBES, 2000a; ACS and ARMINGTON, 2004; COMBES et al., 2004; LOVERIDGE and NIZALOV, 2007; GLAESER and KERR, 2009). Although researchers continue to expand the volume of empirical work on industrial structure characteristics (recent studies include ALMEIDA, 2007; BOSCHMA and IAMMARINO, 2009; BISHOP and GRIPAIOS, 2010; GLAESER et al., 2010; GROOT et al., 2011; ILLY et al., 2011; RENSKI, 2011), a much smaller contingent has found support for or even attempted to examine all three types of externalities (diversity, specialization, and competition) simultaneously.[1] Studies often

include only one or two externality types at a time, with competitive structure the most frequently absent. Most analyses generate evidence of diversity or specialization or both positively influencing economic performance; contradictory results across industries and settings as well as variation in research design preclude more precise conclusions. Studies that do consider the competitive structure of the local industry along with other agglomeration influences have generally found either positive effects arising from both industrial specialization and concentration (i.e., a lack of competition), implying the value of market power, or negative impacts of concentration in conjunction with advantages from diversity, suggesting that industry-specific competition complements cross-industry diversity (BEAUDRY and SCHIFFAUEROVA, 2009). With competing theoretical explanations, the expectation for the influence of competitive structure is ambiguous, especially when evaluated together with diversity, specialization, or other agglomeration externalities.

Some studies of agglomeration have gone further in using micro-level data to differentiate among particular sources of agglomeration advantage, such as labor pooling, supply pooling, and knowledge spillovers, rather than grouping them together as industrial specialization (DUMAIS et al., 1997; FESER, 2001; ROSENTHAL and STRANGE, 2001; FESER, 2002; RIGBY and ESSLETZBICHLER, 2002; HENDERSON, 2003; RENSKI, 2006; BALDWIN et al., 2008). Several recent studies positioned in the evolutionary economic geography genre have explored industry and firm life cycles, producing evidence that youthful plants and industries benefit more from economic diversity whereas specialization favors mature industries (DURANTON and PUGA, 2001; BOSCHMA and WENTING, 2007; NEFFKE et al., 2011; POTTER and WATTS, 2011; NEFFKE et al., 2012). This approach improves internal validity, but also has shortcomings. Agglomeration measures tend to exhibit substantial

empirical multicollinearity, making it difficult to distinguish their effects. Difficulties in accessing micro-level data, and the restrictions placed upon their disclosure, have forced most of these studies to examine relatively narrow economic swathes, either in terms of geography or regarding industrial classifications. And as with investigations of the broader characteristics of industrial diversity and specialization, few researchers have explored competitive industrial structures and other sources of agglomeration economies simultaneously.

Empirical Approach

This paper adopts a conditional, non-causal framework to investigating the impacts of local industrial structure. Regression analyses are conducted to examine conditional relationships among the variables of interest and discern the relative importance of a competitive industrial structure vis-à-vis the diversity of sectoral composition and the degree of industrial specialization. The regressions are non-causal in the sense that the models are not presented as full specifications for predicting regional industry employment. The analyses are not applied to test a predetermined hypothesis or to judge causal inferences. Instead, regression is employed solely as a quantitative tool for revealing the relative influences of different features of local industrial structure on changes in employment. Such an empirical approach is useful for describing associations and identifying patterns, particularly in situations for which statistical assumptions and inferences may be fragile (TUKEY, 1977; LEAMER, 1983). In this case, the subject—the relative influence of different aspects of industrial structure on economic performance—is one for which precise causal relationships are not generally agreed upon or easily operationalized.[2] The value of the non-causal regression approach, recently endorsed by BERK, 2010, as "Level 1 Regression Analysis", lies in its broad suitability for uncovering

relational information in circumstances in which omitted variables or incorrect statistical assumptions may invalidate causal inferences. Moreover, because the data analyzed in this paper constitute a population (*viz*., United States metropolitan areas) rather than a representative sample, there is no need to produce statistical inferences that apply to a larger population. Thus the conditionality of the findings on the set of observations examined does not functionally restrict their generalizability.

Two sets of regression analyses are conducted at contrasting scales of industrial aggregation, because the mechanisms by which industrial co-location influences economic performance may operate differently according to the degree of industrial similarity. First, the manufacturing sector as a whole is examined, with the focus placed on the impacts of competitive structure and diversity considered at the scale of the manufacturing sector. The second set of regressions analyzes the industrial subsectors that comprise the manufacturing sector, adding the degree of industrial specialization and competitive structure at the subsector level as independent variables.

Employment growth is the dependent variable in both sets of regressions. Although employment has its faults as an indicator of performance[3], it is an outcome that is appropriate at the scale of regions rather than individual firms and that is highly relevant to policymakers. Examining employment permits comparison with a large segment of the recent literature (e.g., COMBES et al., 2004; BLIEN et al., 2006; MAMELI et al., 2008; FUCHS, 2011).

Data Source

The principal data come from the confidential establishment-level records of the *Census of Manufactures* (CM) of the United States Census Bureau.[4] The CM, conducted in years ending

in -2 or -7, contains information on establishment locations (counties), primary industry classification, and other establishment characteristics (detailed in MCGUCKIN, 1990). These microdata have been used fruitfully in other regional agglomeration studies (e.g., FESER, 2002; HENDERSON, 2003; GLAESER and KERR, 2009). Although 2002 data were available, the regressions focus on the period from 1987 to 1997 as the most recent decade available prior to the switch from the Standard Industrial Classification (SIC) system to the North American Industrial Classification System (NAICS) in 1997. The results of the subsector regressions are presented with qualitative summaries to satisfy disclosure screening requirements that limit the types and quantity of information possible to extract.

Measures of Industrial Structure

Most previous empirical research investigating competitive structure at a regional scale has measured the concept with average firm or plant size, calculable from publicly available secondary data sources (e.g., County Business Patterns or the public release Census of Manufactures). Average size is an inaccurate proxy for competitive structure, as firms may encompass multiple establishments of varying sizes in a given locality, and furthermore may conflate internal scale economies with competition (COMBES, 2000b; BLIEN et al., 2006). For this research, industrial competitive structure is indicated by measures of regional industrial structure concentration based on relative size (i.e., relative to the scale of the regional industry) and calculated using establishment-level data. Earlier work by the author using these variables documents shifts in concentration over time and across multi-state regions of the United States, and models the relationship between concentration and productivity at the plant level (DRUCKER, 2011; DRUCKER and FESER, 2012; DRUCKER, 2013).

Four employment-based measures of industrial structure concentration are tested. They are regional analogues of indicators applied at the national scale in the industrial organization literature (HAY and MORRIS, 1991; POWELL and LLOYD, 2005). The use of multiple indicators is appropriate given the absence of evidence indicating the superiority of any one measure (AMATO, 1995) and also gauges the robustness of the findings with regard to the specification of the key independent variable.[5] The first measure is a five-firm concentration ratio. Concentration ratios are probably the most widely used measure of industrial concentration, partly because they are available at the national level in public-release versions of the U.S. Census of Manufactures (GOLAN et al., 1996). Establishments are aggregated to the level of firms based on the same-industry same-region manufacturing components of multi-unit firms. The concentration ratio is the ratio of employment in the five largest firms to total regional employment in the industry. Because regional industrial structure concentration is only meaningful in situations in which "dominant" companies can be distinguished from a larger set of influenced firms, regions containing fewer than twelve firms in the industry are excluded from the subsector-specific regressions.[6]

Measures constructed from the full set of firm size shares present the advantage of taking into account the entire size distribution and therefore being sensitive both to the total number of firms and to the relative distribution of size among firms; concentration ratios depend on a single point in the size distribution. Three full size distribution indices are distinguished by the weights placed on the firm size shares. The Herfindahl-Hirschman index weights each size share proportionally to firm size by summing the squared firm shares of regional industry employment. These weights emphasize the largest firms, so the index is insensitive to the size distribution among small firms. Theil's entropy measure weights by the natural logarithm of the size shares,

reducing the emphasis placed on the largest firms. The Rosenbluth index instead weights by descending firm size rank, stressing the small end of the firm size distribution. The minimum of twelve regional industry firms is imposed to preserve the meaningfulness of the competitive structure variable and to maintain identical estimation samples. Table 1 lists the four regional industrial structure concentration measures, their formulae, and theoretical ranges. Appendix Table 1 contains the means, standard deviations, and correlations of the measures across the manufacturing sector.

[Table 1 near here]

Economic diversity is captured with a Herfindahl-Hirschman index. The formula is nearly identical to that provided in Table 1, with the subscript *i* indexing four-digit SIC industries within the manufacturing sector rather than individual firms. The Herfindahl-Hirschman index is subtracted from one to indicate diversity since the index corresponds directly to concentration. Industrial specialization, considered only at the subsector level, is indicated by a location quotient calculated relative to the national manufacturing sector. Both measures are standard in the literature, permitting the analysis to focus on the contribution to assessing regional industrial competitive structure without creating excessive combinations of independent variables.[7]

Regions

The geographic units are Metropolitan Statistical Areas (MSAs) and Consolidated MSAs (CMSAs) defined by 1999 populations (UNITED STATES CENSUS BUREAU, 2002).[8] Metropolitan areas are appropriate in that they approximate functional economic areas across which industrial structures may be expected to influence interfirm interactions. There are 275 MSAs and CMSAs in the contiguous United States; Alaskan and Hawaiian regions are excluded

due to their isolated locations. For the subsector-specific regressions, regions with fewer than twelve firms in the industry are omitted.[9]

Manufacturing Sector Results

Table 2 presents the correlations among the variables included in the regression at the manufacturing sector scale, demonstrating that though industrial structure concentration often is associated with lack of economic diversity there is sufficient distinction between the two variables for effective analysis and interpretation. The results of the regression are reported in Table 3, with regional industrial competitive structure measured by the five-firm concentration ratio. The level of manufacturing employment in 1987 is included to control for the absolute size of the regional manufacturing sector.[10] Dummy variables for Census Regions, with the Northeast as the default, account for macro-regional economic conditions.[11,12] Correcting for possible spatial dependence at the metropolitan scale does not alter the interpretation of any of the results shown.[13] Because the metropolitan regions as units of analysis constitute a population rather than a representative sample, statistical significance is not relevant for inference to a larger population. The substantive meaning in the regression comes mainly from the signs of the estimates and their magnitude relative to sample variation as indicated by significance measures, rather than the raw coefficient estimates.

[Table 2 near here]

[Table 3 near here]

Manufacturing concentration is substantially and negatively associated with employment change. A region with a concentration ratio one standard deviation above than the mean would be expected to have lost approximately 5,100 more manufacturing jobs over the decade than a

region with average concentration (0.566 versus 0.394; see Appendix Table 1).[14,15] Because manufacturing employment in 1987 is included as a control, the impact figure can be interpreted as independent of the starting level of employment. The diversity coefficient is positive, counter to theoretical expectations (recall that the Herfindahl-Hirschman index corresponds inversely to diversity), but it is not significant. Moreover, the difference between the employment change expected for a region one standard deviation above the average economic diversity and expected for a region possessing the mean diversity level is less than a fifth the size of the corresponding 5,100 difference calculated for manufacturing concentration.[16] The evidence is that competitive structure, as indicated by concentration, is more powerfully linked to employment change than is manufacturing sector diversity.

There are at least two ready statistical explanations for the weak influence of diversity on employment change. The manufacturing diversity variable exhibits limited variation across metropolitan regions, making it difficult to ascertain its potential influence. A more substantive explanation is that industrial structure concentration and diversity are negatively correlated: industrially concentrated regions tend not to be diverse, and diverse areas usually have more competitive industrial structures.[17] This relationship is related to the scale of the region as well, with larger regions typically possessing greater diversity. Therefore, collinearity between the two independent variables may be masking the independent influence of diversity on employment change.[18]

As for the control variables, the 1987 count of manufacturing employees is negative and highly significant. In a period of manufacturing decline at the national level, regions with larger manufacturing sectors would be expected to shed more employment. Southern, Midwestern, and particularly Western areas experienced greater employment growth, or smaller losses of

manufacturing jobs, than metropolitan regions in the Northeast.

Table 4 displays the results obtained by substituting the other measures of competitive structure for the five-firm concentration ratio. (Appendix Table 2 offers the corresponding variable correlations.) Table 5 shows the estimated employment changes from 1987 to 1997 associated with an increase in manufacturing concentration of one standard deviation for all four of the measures. The Rosenbluth index yields results very similar to the five-firm concentration ratio, suggesting that the small end of the firm size distribution is not crucial. The relationship between the Herfindahl-Hirschman concentration index and employment change is smaller and weaker than for the other measures, perhaps diminished by the similarity in construction of the concentration and diversity variables. The degree of the deviation across measures—within an order of magnitude—is reasonable since the variation across regions is not standardized. The estimated diversity coefficients in Table 4 vary in sign and significance, whereas the estimates for the control variables do not differ notably from Table 3, further supporting the implication that industrial competitive structure matters more than economic diversity in determining manufacturing employment performance over time.

[Table 4 near here]

[Table 5 near here]

Table 6 presents results obtained by omitting either the manufacturing diversity or the competitive structure (industrial concentration) variable from the regression. The first two columns repeat the results from Tables 3 and 4 for reference (showing only the coefficients of concentration and diversity; the other estimates remain similar to those presented earlier). The second and third pairs of columns—*Diversity Omitted* and *Concentration Omitted*—contain new information. The estimated relationship between employment change and any of the four

concentration measures is stronger with diversity omitted than between employment change and diversity with concentration dropped, reinforcing the finding that industrial competitive structure is more strongly linked than manufacturing diversity to employment. This experiment encourages caution in evaluating empirical assessments of the influence of economic diversity, as estimates may depend on whether and how other aspects of industrial structure such as competition are included. Again, the substantial negative correlation between regional concentration and diversity in the manufacturing sector is apparent, and the resultant collinearity in the regression model that includes both variables surely explains a portion of the changes in the estimated coefficient values. Comparing the first two columns—*Both Variables*—with the other four, the concentration coefficient estimates increase in significance when diversity is removed (except for Theil's entropy measure, which is highly significant with either specification), as does the diversity variable when concentration is excluded. Empirically, diversity is not a common attribute of manufacturing sectors that are dominated by one or a few large firms.

[Table 6 near here]

Subsector Results

The two-digit SIC subsectors that comprise the manufacturing sector are listed in Table 7. A separate regression was performed for each subsector, not to analyze individual subsectors but rather to investigate industrial structure features at a finer grain by comparing findings across smaller, more homogeneous groupings of firms. The geographic units remain MSAs and CMSAs, excluding those without at least twelve firms in the subsector in 1987 to ensure the meaningfulness of the concentration variables. For a few of the subsectors, the small number of metropolitan areas leads to imprecise estimates.

[Table 7 near here]

The dependent variable in each regression is the change in subsector employment from 1987 to 1997. Competitive structure is measured by regional industrial structure concentration at two scales of aggregation: the subsector and manufacturing-wide. Diversity is measured for the manufacturing sector as a whole, since benefits such as Jacobs externalities arise from differences rather than similarities among economic activities. Industrial specialization at the subsector scale is included with location quotients calculated relative to the national manufacturing sector. The control variables from the previous section are retained.[19] As before, the application of standard spatial correction models does not alter the results.[20]

Table 8 summarizes the estimates for the regional industrial structure variables: subsector concentration, manufacturing-wide concentration, manufacturing diversity, and subsector specialization. Concentration is measured with the five-firm concentration ratio. The signs and significance ranges are presented, but not the parameter estimates. This simplification serves two purposes: it facilitates visual comparison across the series of regressions, and it complies with disclosure screening limitations. Because fewer observations are involved in these regressions, probability values are noted at the 90 percent as well as the 95 and 99 percent confidence levels.

[Table 8 near here]

Competitive structure at the subsector level is the most important of the four variables shown. Subsector concentration is a negative and significant influence on employment change in about half of the subsectors, and has insignificant (as opposed to clearly positive) effects in the other half. Several of the subsectors in which subsector concentration is only weakly related to employment change are those with fewer suitable metropolitan regions as observations, such as

petroleum and coal (SIC 29), leather (SIC 31), and primary metals (SIC 33). The other industrial structure variables are far less prominent. Neither manufacturing-wide competitive structure nor diversity is substantially associated with employment shifts at the subsector scale. It may be that at the 2-digit scale of aggregation, most of the subsectors are dominated in terms of employment by industries in the mature stage of their life cycles, and thus reap little benefit from regional economic diversity (NEFFKE et al., 2011). Subsector specialization has mostly positive effects but they are strong only in a few subsectors: lumber and wood products (SIC 24), furniture and fixtures (SIC 25), paper and allied products (SIC 26), and transportation equipment (SIC 37). Again, in most regions of the country, these subsectors are comprised largely of industries and firms in the mature stages of their life cycles that likely benefit more from localization than diversity. Similar results obtain when the other concentration measures substitute for the concentration ratio (see Appendix Figure 1).[21]

Repeating the experiment of omitting either subsector concentration or manufacturing diversity from the regressions yields the coefficients displayed in Table 9. There are few changes in statistical significance for the industrial structure variables (compare to Table 8). For most subsectors, employment change remains more strongly associated with competitive structure than diversity when the structural characteristics are assessed separately. With diversity removed, the R^2 values decline only slightly, indicating little loss of explanation for the variation in the dependent variable, but when subsector concentration is dropped the R^2 values fall substantially in many subsectors. Subsector concentration is more closely linked to employment performance than is manufacturing diversity.

[Table 9 near here]

Summary and Implications

This paper explores the relationships of different aspects of local industrial structure to economic performance as indicated by employment growth for the United States manufacturing sector and its subsectors. Less competitive industrial structures at the regional scale are negatively associated with employment change. Measured during the decade from 1987 to 1997, a time of national decline in manufacturing employment, greater regional structural concentration in the manufacturing sector increases the expected job loss substantially. The relationship is robust (within an order of magnitude) across four measures of industrial structure concentration. The influence of diversity is much weaker and is not stable across the different concentration measures of competitive structure. The failure to find strong associations between manufacturing diversity and employment growth may be partially due to empirical overlap in the incidence of diversity and concentration, yet additional tests corroborate the outcome that manufacturing competitive structure presents a much stronger link to employment than does diversity. Empirical assessments of diversity impacts that do not include any measure or consideration of competitive structure may produce misleading conclusions.

The results at the subsector level also emphasize the importance of industrial competitive structure throughout the manufacturing sector. In fact, perhaps the most important impression to be obtained from Tables 8 and 9 is the similarity of the associations measured across widely divergent industries. Aside from the handful of subsectors for which there are few observations reliability, concentration within local manufacturing subsectors is nearly uniformly a more important influence on employment change than diversity or manufacturing-wide concentration. For all but one of the nineteen subsectors evaluated, neither the diversity nor the manufacturing sector concentration variables demonstrates a significant association with employment change.

Specialization does have a strong positive relationship to employment growth in a few subsectors; these subsectors contain relatively mature, less innovation-intensive industries. There is much less evidence of concentration within subsectors overlapping with manufacturing diversity than was the case for manufacturing-wide concentration.

The importance of industrial competitive structure points to several directions for further research. First, competitive structure should be included in studies of externalities arising from the spatial agglomeration of firms and industries as an influential attribute of regional economies distinct from other commonly examined traits such as economic diversity and industrial specialization. Causal analyses that omit competitive structure may yield biased findings. In addition, the strength of the association between concentration and economic performance at the regional scale offers an important and largely overlooked explanation for observed regional and temporal differences in the evolution of industry sectors and the benefits of agglomeration. Second, the approach of exploring multiple co-location features simultaneously can be applied usefully in fully-specified causal models and to evaluate economic outcomes other than employment, such as firm births, productivity, and innovation. Third, refinements of the diversity and specialization concepts, such as related diversity (FRENKEN et al., 2007) and vertical integration (CAINELLI and IACOBUCCI, 2012), may add depth to the analysis of industrial structure. Finally, micro-level data, though typically difficult to access, are vital for creating accurate measures of industrial structure that appropriately characterize agglomeration at the regional scale. Applying such metrics to examinations of additional regions, time frames, and types of economic performance may help to resolve some of the inconsistencies and disagreements that pervade the empirical literature on the sources of regional agglomeration economies.

Notes

[1] The meta-analysis conducted by BEAUDRY and SCHIFFAUEROVA, 2009, found that only 25 of the 67 studies reviewed examined competition together with diversity and specialization externalities. In the majority of these 25 studies one or more of the three characteristics failed to generate decisive results. Similarly, 13 of the 31 studies reviewed by DE GROOT et al., 2009, considered the three traits together, of which eight yielded inconclusive findings for at least one of the externality types.

[2] Readers should be aware of methodological concerns prevalent in industrial structure and agglomeration research such as unobserved heterogeneity and possible endogeneity. There may be additional characteristics of firms, industries, or regions not included in the analyses presented that influence manufacturing employment change, and endogeneity may arise if the firms most likely to grow best select locations supportive of employment increases. In a non-causal framework, these concerns are not paramount as the goal is to compare rather than to isolate and specify precisely the magnitude of each independent relationship.

[3] For example, employment may decline as productivity and capital intensity increase. Also, regional employment change may feed back into enduring industrial structure characteristics, though such a causal pathway is not a likely explanation for the major findings of this study (see note 14).

[4] The CM data were accessed via the *Longitudinal Research Database* (LRD), a dataset that contains all of the information from the various years of the CM as well as the *Annual Survey of Manufacturers*. Some of the listed works refer to the LRD rather than the CM.

[5] The concept of industrial structure concentration intrinsically involves comparisons between a set of plants or firms and the individuals comprising that set, leading to possible ambiguities in

indicator interpretation. Here, the application of several ratios as indicators that differ chiefly in their numerators assists in attributing and evaluating the findings.

[6] Robustness checks were conducted by setting the threshold as low as six and as high as fifty firms in the regional industry, producing results with qualitative interpretations that are the same as those presented.

[7] COMBES et al., 2004, and FRENKEN et al., 2007, have proposed refinements to measuring economic diversity, but the appropriate level of industrial disaggregation at which to apply multiple measures of diversity and their intersection with other co-location concepts remains obscure. For example, at what degree of dissimilarity among firms do agglomeration effects switch from being cross-industry (diversity) externalities to within-industry (specialization or competition) externalities?

[8] In using the 1999 definitions, this study errs on the side of inclusivity; relatively small counties and rural counties that had little interaction with central cities and the immediately surrounding urbanized areas in the earlier portion of the decade will not alter analytical outcomes extensively. Checks using primary MSAs (PMSAs) instead of CMSAs yield similar results to those presented.

[9] Disclosure protections preclude divulging the particular regions included for each subsector.

[10] Although the initial level of manufacturing employment is also the denominator of the concentration ratio, its inclusion helps to distinguish the effects of regional scale from

ecifications were tested, including using the percentage change in
pendent variable, using the local (i.e., competitive) term from a classical
tion as the dependent variable, substituting firm counts or total value added
dependent variable, adding lagged concentration and diversity measures,
nal controls by Census Divisions rather than Census Regions, and
to two five-year intervals. Each of these specifications produced results in
tive findings and interpretations described in the text.
eroskedasticity test does not reject homoskedasticity at conventional
d the heteroskedasticity-adjusted probability values are little different than

al Moran's I and LaGrange multiplier statistics) suggested the existence of
dence with a lag interpretation dominant. Yet a spatial lag model using an
ts matrix based on MSA and CMSA centroids yielded coefficient
o substantive differences from the ordinary least squares estimates
or the Census Region dummy variables. The same held true for a spatial
er should note that the possibility remains of spatial processes that operate

would imply a positive sign for the concentration variable coefficient.

ent change does in some cases lead to increases in concentration, the

ually may understate the effect of concentration on manufacturing

ns disallow the provision of lists or counts of regions that might elucidate

owever, similar comparisons conducted by the author involving alternate

, such as smaller fractions of standard deviations, yielded comparable

s.

re would require descriptive statistics for the economic diversity measure

or release.

e statistics and correlations are not approved for disclosure.

ween regional scale and diversity may have a causal as well as a statistical

ANTON and PUGA, 2001.

s are available from the author upon request.

ealed little or no spatial dependence for most industries, and employing

spatial error model did not alter the results substantively for any of the

Acknowledgements

This work has been supported by awards from the National Science Foundation (grant NSF-BCS 0423900), the Ewing Marion Kauffman Foundation, and the North American Regional Science Council. Additional support for the Triangle Census Research Data Center comes from the National Science Foundation (grants NSF-SES 0004322 and NSF-ITR 0427889).

Appendix

[Appendix Table 1 here]

[Appendix Table 2 here]

[Appendix Figure 1 here]

References

ACS Z. J. and ARMINGTON C. (2004) Employment growth and entrepreneurial activity in cities, Regional Studies 38 (8), 911-27.

AGRAWAL A. K. and COCKBURN I. M. (2003) The anchor tenant hypothesis: exploring the role of large, local, R&D-intensive firms in regional innovation systems, International Journal of Industrial Organization 21 (9), 1227-53.

ALMEIDA R. (2007) Local economic structure and growth, Spatial Economic Analysis 2 (1), 65-90.

AMATO L. (1995) The choice of structure measure in industrial economics, Quarterly Journal of Business and Economics 34 (2), 39-52.

AUDRETSCH D. B. (2001) Research issues related to structure, competition, and performance of small technology-based firms, Small Business Economics 16 (1), 37-51.

AUDRETSCH D. B. (2003) Innovation and spatial externalities, International Regional Science Review 26 (2), 167-74.

BALDWIN J. R., BECKSTEAD D., BROWN W. M. and RIGBY D. L. (2008) Agglomeration and the geography of localization economies in Canada, Regional Studies 42 (1), 117-32.

BEAUDRY C. and SCHIFFAUEROVA A. (2009) Who's right, Marshall or Jacobs? The localization versus urbanization debate, Research Policy 38 (2), 318-37.

BERK R. (2010) What you can and can't properly do with regression, Journal of Quantitative Criminology 26 (4), 481-7.

BISHOP P. and GRIPAIOS P. (2010) Spatial externalities, relatedness and sector employment growth in Great Britain, Regional Studies 44 (4), 443-54.

BLIEN U., SUEDEKUM J. and WOLF K. (2006) Local employment growth in West Germany: a dynamic panel approach, Labour Economics 13 (4), 445-58.

BOOTH D. E. (1986) Long waves and uneven regional growth, Southern Economic Journal 53 (2), 448-60.

BOSCHMA R. A. and FRENKEN K. (2011) The emerging empirics of evolutionary economic geography, Journal of Economic Geography 11 (2), 295-307.

BOSCHMA R. A. and IAMMARINO S. (2009) Related variety, trade linkages, and regional growth in Italy, Economic Geography 85 (3), 289-311.

BOSCHMA R. A. and WENTING R. (2007) The spatial evolution of the British automobile industry: does location matter? Industrial and Corporate Change 16 (2), 213-38.

BREWER H. L. (1985) Measures of diversification: predictors of regional economic instability, Journal of Regional Science 25 (3), 463-70.

CAINELLI G. and IACOBUCCI D. (2012) Agglomeration, related variety, and vertical integration, Economic Geography 88 (3), 255-77.

CARREE M. and THURIK R. (1999) Industrial structure and economic growth, in AUDRETSCH D. and THURIK R. (Eds) Innovation, Industry Evolution, and Employment, pp. 86-110. Cambridge University Press, Cambridge.

COMBES P.-P. (2000a) Economic structure and local growth: France, 1984-1993, Journal of Urban Economics 47 (3), 329-55.

COMBES P.-P. (2000b) Marshall-Arrow-Romer externalities and city growth, Working Paper 99-06, CERAS, http://www.vcharite.univ-mrs.fr/pp/combes/note.pdf.

COMBES P.-P., MAGNAC T. and ROBIN J.-M. (2004) The dynamics of local employment in France, Journal of Urban Economics 56 (2), 217-43.

COMBES P.-P. and OVERMAN H. G. (2004) The spatial distribution of economic activities in the European Union, in HENDERSON J. V. and THISSE J.-F. (Eds) Handbook of Urban and Regional Economics Vol. 4, pp. 2845-909. Elsevier, North Holland.

DE GROOT H. L. F., POOT J. and SMIT M. J. (2009) Agglomeration externalities, innovation and regional growth: theoretical perspectives and meta-analysis, in CAPELLO R. and NIJKAMP P. (Eds) Handbook of Regional Growth and Development Theories, pp. 256-81. Edward Elgar, Cheltenham.

DISSART J. C. (2003) Regional economic diversity and regional economic stability: research results and agenda, International Regional Science Review 26 (4), 423-46.

DRUCKER J. (2011) Regional industrial concentration in the United States: trends and implications, Economic Geography 87 (4), 421-52.

DRUCKER J. (2013) Industrial structure and the sources of agglomeration economies: evidence from manufacturing plant production, Growth and Change 44 (1), 54-91.

DRUCKER J. and FESER E. J. (2012) Regional industrial structure and agglomeration economies: An analysis of productivity in three manufacturing industries, Regional Science and Urban Economics 42 (1-2), 1-14.

DUMAIS G., ELLISON G. and GLAESER E. L. (1997) Geographic concentration as a dynamic process, Working Paper 6270, National Bureau of Economic Research, http://www.nber.org/papers/w6270.

DURANTON G. and PUGA D. (2001) Nursery cities: urban diversity, process innovation, and the life cycle of products, The American Economic Review 91 (5), 1454-77.

ENRIGHT M. (1995) Organization and coordination in geographically concentrated industries, in LAMOREAUX N. R. and RAFF D. M. G. (Eds) Coordination and Information:

Historical Perspectives on the Organization of Enterprise, pp. 103-46. University of Chicago Press, Chicago.

ESSLETZBICHLER J. and RIGBY D. L. (2007) Exploring evolutionary economic geographies, Journal of Economic Geography 7 (5), 549-71.

FELDMAN M. P. (2003) The locational dynamics of the US biotech industry: knowledge externalities and the anchor hypothesis, Industry and Innovation 10 (3), 311-28.

FESER E. J. (2001) Agglomeration, enterprise size, and productivity, in JOHANSSON B., KARLSSON C. and STOUGH R. (Eds) Theories of Endogenous Regional Growth: Lessons for Regional Policies, pp. 231-51. Springer-Verlag, Berlin.

FESER E. J. (2002) Tracing the sources of local external economies, Urban Studies 39 (13), 2485-506.

FRENKEN K., VAN OORT F. G. and VERBURG T. (2007) Related variety, unrelated variety and regional economic growth, Regional Studies 41 (5), 685-97.

FUCHS M. (2011) The determinants of local employment dynamics in Western Germany, Empirical Economics 40 (1), 177-203.

GLAESER E. L., KALLAL H. D., SCHEINKMAN J. A. and SCHLEIFER A. (1992) Growth in cities, Journal of Political Economy 100 (6), 1126-52.

GLAESER E. L. and KERR W. R. (2009) Local industrial conditions and entrepreneurship: how much of the spatial distribution can we explain? Journal of Economics and Management Strategy 18 (3), 623-63.

GLAESER E. L., KERR W. R. and PONZETTO G. A. M. (2010) Clusters of entrepreneurship, Journal of Urban Economics 67 (1), 150-68.

GOLAN A., JUDGE G. and PERLOFF J. M. (1996) Estimating the size distribution of firms using government summary statistics, The Journal of Industrial Economics 44 (1), 69-80.

GROOT S. P. T., DE GROOT H. and SMIT M. J. (2011) Regional wage differences in the Netherlands: micro-evidence on agglomeration externalities, Tinbergen Institute, Amsterdam, http://www.tinbergen.nl/discussionpapers/11050.pdf.

HANSON G. H. (2001) Scale economies and the geographic concentration of industry, Journal of Economic Geography 1 (3), 255-76.

HAY D. A. and MORRIS D. J. (1991) Industrial Economics and Organization: Theory and Evidence. Oxford University Press, Oxford.

HENDERSON J. V. (1997) Externalities and industrial development, Journal of Urban Economics 42 (3), 449-70.

HENDERSON J. V. (2003) Marshall's scale economies, Journal of Urban Economics 53 (1), 1-28.

HENDERSON J. V., KUNCORO A. and TURNER M. A. (1995) Industrial development in cities, Journal of Political Economy 103 (5), 1067-90.

HENDERSON J. V., SHALIZI Z., and VENABLES A. J. (2001) Geography and development, Journal of Economic Geography 1 (1), 81-105.

ILLY A., SCHWARTZ M., HORNYCH C. and ROSENFELD M. T. W. (2011) Local economic structure and sectoral employment growth in German cities, Tijdschrift voor Economische en Sociale Geografie 102 (5), 582-93.

IZRAELI O. and MURPHY K. J. (2003) The effect of industrial diversity on state unemployment rate and per capita income, Annals of Regional Science 37 (1), 1-14.

JACOBS J. (1969) The Economy of Cities. Random House, New York.

LEAMER E. E. (1983) Let's take the con out of econometrics, The American Economic Review 73 (1), 31-43.

LOVERIDGE S. and NIZALOV D. (2007) Operationalizing the entrepreneurial pipeline theory: an empirical assessment of the optimal size distribution of local firms, Economic Development Quarterly 21 (3), 244-62.

MALIZIA E. E. and KE S. (1993) The influence of economic diversity on unemployment and stability, Journal of Regional Science 33 (2), 221-35.

MALMBERG A. and MASKELL P. (2002) The elusive concept of localization economies: towards a knowledge-based theory of spatial clustering, Environment and Planning A 34 (3), 429-49.

MAMELI F., FAGGIAN A. and MCCANN P. (2008) Employment growth in Italian local labour systems: issues of model specification and sectoral aggregation, Spatial Economic Analysis 3 (3), 343-59.

MCGUCKIN R. H. (1990) Longitudinal economic data at the Census Bureau: A new database yields fresh insights on some old issues, Working Paper CES-WP-90-1, Center for Economic Studies, United States Census Bureau, http://ideas.repec.org/p/cen/wpaper/90-1.html.

MELO P. C., GRAHAM D. J. and NOLAND R. B. (2009) A meta-analysis of estimates of urban agglomeration economies, Regional Science and Urban Economics 39 (3), 332-42.

MIZUNO K., MIZUTANI F. and NAKAYAMA N. (2006) Industrial diversity and metropolitan unemployment rate, Annals of Regional Science 40 (1), 157-72.

NEFFKE F. M. H., HENNING M. and BOSCHMA R. A. (2012) The impact of aging and technological relatedness on agglomeration externalities: a survival analysis, Journal of Economic Geography 12 (2), 485-517.

NEFFKE F. M. H., HENNING M., BOSCHMA R. A., LUNDQUIST K.-J. and OLANDER L.-O. (2011) The dynamics of agglomeration externalities along the life cycle of industries, Regional Studies 45 (1), 49-65.

NELSON R. R. and WINTER S. G. (1982) An Evolutionary Theory of Economic Change. Harvard University Press, Cambridge.

PORTER M. E. (1990) The Competitive Advantage of Nations. MacMillan, New York.

PORTER M. E. (1998) Clusters and the new economics of competition, Harvard Business Review (November/December), 77-90.

POTTER A. and WATTS H. D. (2011) Evolutionary agglomeration theory: increasing returns, diminishing returns, and the industry life cycle, Journal of Economic Geography 11 (3), 417-55.

POWELL T. C. and LLOYD C. J. (2005) Toward a general theory of competitive dominance: comments and extensions on Powell (2003), Strategic Management Journal 26 (4), 385-94.

PUGA D. (2010) The magnitude and causes of agglomeration economies, Journal of Regional Science 50 (1), 203-19

RENSKI H. C. (2006) An investigation of the industrial ecology of business start-up survival, doctoral dissertation, Department of City and Regional Planning, University of North Carolina, Chapel Hill.

RENSKI H. C. (2011) External economies of localization, urbanization and industrial diversity and new firm survival, Papers in Regional Science 90 (3), 473-503.

RIGBY D. L. and ESSLETZBICHLER J. (2002) Agglomeration economies and productivity differences in US cities, Journal of Economic Geography 2 (4), 407-32.

ROSENTHAL S. S. and STRANGE W. C. (2001) The determinants of agglomeration, Journal of Urban Economics 50 (2), 191-229.

ROSENTHAL S. S. and STRANGE W. C. (2004) Evidence on the nature and sources of agglomeration economies, in HENDERSON J. V. and THISSE J.-F. (Eds) Handbook of Urban and Regional Economics Vol. 4, pp. 2119-71. Elsevier, Amsterdam.

SAXENIAN A. (1994) Regional Advantage: Culture and Competition in Silicon Valley and Route 128. Harvard University Press, Cambridge.

SCOTT A. J. (1988) New Industrial Spaces: Flexible Production Organization and Regional Development in North America and Western Europe. Pion Limited, London.

TUKEY J. W. (1977) Exploratory Data Analysis. Addison-Wesley, Reading.

UNITED STATES CENSUS BUREAU. (2002) Metropolitan Areas and Components, 1999, http://www.census.gov/population/estimates/metro-city/99mfips.txt.

UNITED STATES CENSUS BUREAU. (n.d.) County Business Patterns, http://www.census.gov/econ/cbp/.

Tables

Table 1. Regional industrial structure concentration measures.

Measure	Description	Formula	Concentration min.	Concentration max.
Five-firm concentration ratio	sum of size shares of five largest firms	$\frac{\sum_{i=1}^{5} E_i}{\sum_i E_i}$	$5/n$	1
Herfindahl-Hirschman index	sum of squared firm size shares	$\sum_i \left(\frac{E_i}{\sum_i E_i} \right)^2$	$1/n$	1
Theil's entropy	sum of firm size shares weighted by natural log of firm size	$\sum_i \frac{E_i\left(-\ln E_i\right)}{\sum_i E_i}$	$-\ln(n)$	0
Rosenbluth index	sum of firm size shares weighted by descending size rank	$\left(2\sum_i \left(i \cdot \frac{E_i}{\sum_i E_i} \right) - 1 \right)^{-1}$	$1/n$	1

Note: n is the number of firms in the regional industry, i indexes the firms in the regional industry in descending size order, and E_i represents the employment of the i^{th} firm.

Table 2. Variable correlations: manufacturing sector.

	Mfg. Empl.	Concentration	Diversity	South	Midwest	West
1987-1997 Employment Change	-0.7673 **	0.1486 *	0.0807	0.0928	0.0466	0.0444
1987 Manufacturing Employment		-0.3677 **	-0.1981 **	-0.1429 *	-0.0504	0.0301
1987 Concentration (Concentration Ratio)			0.6883 **	0.0097	0.1572 **	0.0034
1987 Diversity (Herfindahl-Hirschman)				-0.1507 *	0.1909 **	0.1244 *

* Significant at the 95% confidence level. ** Significant at the 99% confidence level.

Table 3. Regression results: manufacturing sector.

Variable		Coeff.	Std. Err.	
Dependent Variable: Employment Change, 1987-1997				
Intercept		15,100	3,514	**
1987 Concentration		-29,760	9,145	**
1987 Diversity		9,231	19,007	
1987 Manufacturing Employment		-0.183	0.0092	**
South		1,754	2,610	
Midwest		4,803	4,022	
West		6,444	3,263	*
Observations	275	F Stat.	71.88	
R^2	0.6168	F Prob.	< .0001	

* Significant at the 95% confidence level. ** Significant at the 99% confidence level.

Table 4. Regression results: manufacturing sector, full size distribution concentration measures.

	Herfindahl-Hirschman		Theil's Entropy		Rosenbluth	
Variable	Coeff.	Std. Err.	Coeff.	Std. Err.	Coeff.	Std. Err.
Dependent Variable: Employment Change, 1987-1997						
Intercept	9,128	3,282 **	-35,970	8,224 **	8,943	3,147 **
1987 Concentration	-28,976	23,993	-9,004	1,499 **	-184,853	51,092 **
1987 Diversity	-13,353	21,277	29,831	16,983	2,924	17,066
1987 Manuf. Employment	-0.1750	0.0089 **	-0.218	0.0111 **	-0.181	0.0089 **
South	834	2,648	2,996	2,510	2,372	2,615
Midwest	4,125	4,085	3,855	3,855	5,385	4,013
West	6,214	3,366	6,342	3,121 *	7,055	3,245 *
Observations	275		275		275	
R^2	0.6038		0.6489		0.6202	

* Significant at the 95% confidence level. ** Significant at the 99% confidence level.

Table 5. Estimated effects of standard deviation increase in concentration.

Measure	Employment Change, 1987-1997
Five-Firm Concentration Ratio	-5,107
Herfindahl-Hirschman Index	-2,025
Theil's Entropy	-10,320
Rosenbluth Index	-4,991

Table 6. Selected regression results, omitting diversity or concentration.

	Both Variables		*Diversity Omitted*		*Concentration Omitted*	
Variable	Coeff.	Std. Err.	Coeff.	Std. Err.	Coeff.	Std. Err.
Five-Firm Concentration Ratio						
Concentration	-29,760	9,145 **	-26,772	6,757 **	—	
Diversity	9,231	19,007	—		-32,380	14,312 *
Herfindahl-Hirschman Index						
Concentration	-28,976	23,993	-40,126	16,107 *	—	
Diversity	-13,353	21,277	—		*same as above*	
Theil's Entropy						
Concentration	-9,004	1,499 **	-7,399	1,193 **	—	
Diversity	29,831	16,983	—		*same as above*	
Rosenbluth Index						
Concentration	-184,853	51,092 **	-179,848	41,841 **	—	
Diversity	2,924	17,066	—		*same as above*	

* Significant at the 95% confidence level. ** Significant at the 99% confidence level.

Table 7. Two-digit SIC manufacturing subsectors and United States totals (thousands).

		1987		1997	
SIC	Manufacturing Subsector	Establishments	Employment	Establishments	Employment
20	Food and kindred products	20.8	1,425	21.2	1,540
21	Tobacco products	0.1	44	0.1	34
22	Textile mill products	6.6	691	6.2	553
23	Apparel and other textile products	22.8	1,073	23.9	835
24	Lumber and wood products	34.0	698	37.2	745
25	Furniture and fixtures	11.7	505	12.2	515
26	Paper and allied products	6.4	627	6.5	621
27	Printing and publishing	61.9	1,501	62.6	1,502
28	Chemicals and allied products	12.2	813	12.4	833
29	Petroleum and coal products	2.3	122	2.1	108
30	Rubber and miscellaneous plastics products	13.8	786	16.8	1,015
31	Leather and leather products	2.2	131	1.9	83
32	Stone, clay, and glass products	16.7	544	16.6	501
33	Primary metal industries	6.9	685	6.6	686
34	Fabricated metal products	35.8	1,447	38.7	1,538
35	Industrial machinery and equipment	53.0	1,917	56.7	1,955
36	Electronic and other electical equipment	17.6	1,977	17.4	1,528
37	Transportation equipment	10.3	1,824	12.7	1,574
38	Instruments and related products	9.0	603	11.9	814
39	Miscellaneous manufacturing industries	17.0	388	18.5	399
	MANUFACTURING TOTAL	371.0	19,003	393.1	18,633

Source: County Business Patterns (UNITED STATES CENSUS BUREAU, n.d.).

Note: Column sums do not equal totals due to omission of data from counties with fewer than 50 subsector employees.

Table 8. Regression results for manufacturing subsectors.

Subsector[a]	Obs.	R^2	Subsector Concentration	Manufacturing Concentration	Manufacturing Diversity	Subsector Specialization
20	190	0.19	–	–	–	+
22	43	0.86	– **	+	–	–
23	112	0.37	+	+	–	–
24	208	0.28	– †	+	–	– *
25	101	0.55	–	+	–	+ **
26	69	0.56	– **	–	–	+ **
27	253	0.72	– **	+	–	+
28	118	0.46	– **	–	–	+
29	31	0.60	+	+	+	+
30	117	0.24	– **	+	–	–
31	22	0.88	–	–	+	+
32	157	0.56	–	–	–	–
33	70	0.58	–	–	–	+ †
34	200	0.26	– **	+	–	+
35	225	0.37	– **	–	–	+
36	115	0.14	–	+	–	+
37	110	0.86	+	–	+	+ *
38	84	0.69	– **	+	+	+
39	131	0.73	– **	–	– †	– †

† Significant at the 90% confidence level. * Significant at the 95% confidence level. ** Significant at the 99% confidence level. [a] Subsector 21 has only a single observation and is omitted.

Table 9. Regression results omitting manufacturing diversity or subsector concentration.

		Manufacturing Diversity Omitted				*Subsector Concentration Omitted*			
Subsector[a]	Obs.	R^2	Subsector Concentration	Manufacturing Concentration	Subsector Specialization	R^2	Manufacturing Concentration	Manufacturing Diversity	Subsector Specialization
20	190	0.19	–	–	+	0.18	–	–	+
22	43	0.86	– **	+	–	0.82	+	–	–
23	112	0.37	–	+	–	0.37	–	–	–
24	208	0.28	–	+	– *	0.27	–	–	– *
25	101	0.55	–	+	+ **	0.54	–	–	+ **
26	69	0.56	– **	–	+ **	0.51	–	–	+ **
27	253	0.72	– **	+	+	0.65	–	–	+
28	118	0.46	– **	–	+	0.39	+	–	+
29	31	0.60	+	+	+	0.60	+	+	+
30	117	0.24	– **	+	–	0.15	–	–	–
31	22	0.87	–	–	+	0.87	+	+	+
32	157	0.56	–	–	–	0.56	–	–	–
33	70	0.58	–	–	+ †	0.58	–	–	+ †
34	200	0.26	– **	+	+	0.22	+	–	+
35	225	0.37	– **	–	+	0.35	+	–	+
36	115	0.13	–	+	+	0.12	–	–	+
37	110	0.86	+	–	+ *	0.86	+	+	+ *
38	84	0.69	– **	+	+	0.65	+	+	+
39	131	0.72	– **	–	– †	0.69	–	– †	– †

† Significant at the 90% confidence level. * Significant at the 95% confidence level. ** Significant at the 99% confidence level. [a] Subsector 21 has only a single observation and is omitted.

Appendix Table 1. Measures of structural concentration, 1987.

Measure	Mean	Std. Dev.
Five-Firm Concentration Ratio	0.3940	0.1716
Herfindahl-Hirschman Index	0.0680	0.0699
Theil's Entropy	-4.1223	1.1461
Rosenbluth Index	0.0276	0.0270

Correlations	Herf.-H.	Theil's E.	Rosenb.
Five-Firm Concentration Ratio	0.8551	0.8936	0.8265
Herfindahl-Hirschman Index		0.7073	0.7485
Theil's Entropy			0.7990

Notes: There are 275 MSA and CMSA observations. All correlations are significant at the 99% confidence level.

Appendix Table 2. Variable correlations: manufacturing sector.

	Mfg. Empl.	Concentration	Diversity	South	Midwest	West
1987-1997 Employment Change	-0.7673 **	0.0638	0.0807	0.0928	0.0466	0.0444
1987 Manufacturing Employment		-0.2030 **	-0.1981 **	-0.1429 *	-0.0504	0.0301
1987 Concentration (Herfindahl-Hirschman)			0.7514 **	-0.0935	0.1729 **	-0.0229
1987 Diversity (Herfindahl-Hirschman)				-0.1507 *	0.1909 **	0.1244 *

	Mfg. Empl.	Concentration	Diversity	South	Midwest	West
1987-1997 Employment Change	-0.7673 **	0.3328 **	0.0807	0.0928	0.0466	0.0444
1987 Manufacturing Employment		-0.6505 **	-0.1981 **	-0.1429 *	-0.0504	0.0301
1987 Concentration (Theil's Entropy)			0.5811 **	0.0943	0.1430 *	-0.0240
1987 Diversity (Herfindahl-Hirschman)				-0.1507 *	0.1909 **	0.1244 *

	Mfg. Empl.	Concentration	Diversity	South	Midwest	West
1987-1997 Employment Change	-0.7673 **	0.0881	0.0807	0.0928	0.0466	0.0444
1987 Manufacturing Employment		-0.3056 **	-0.1981 **	-0.1429 *	-0.0504	0.0301
1987 Concentration (Rosenbluth)			0.5949	0.0490	0.1483 *	0.0089
1987 Diversity (Herfindahl-Hirschman)				-0.1507 *	0.1909 **	0.1244 *

* Significant at the 95% confidence level. ** Significant at the 99% confidence level.

Figures

Appendix Figure 1. Counts of Estimated Coefficient Signs and Significance Ranges by Manufacturing Subsectors.

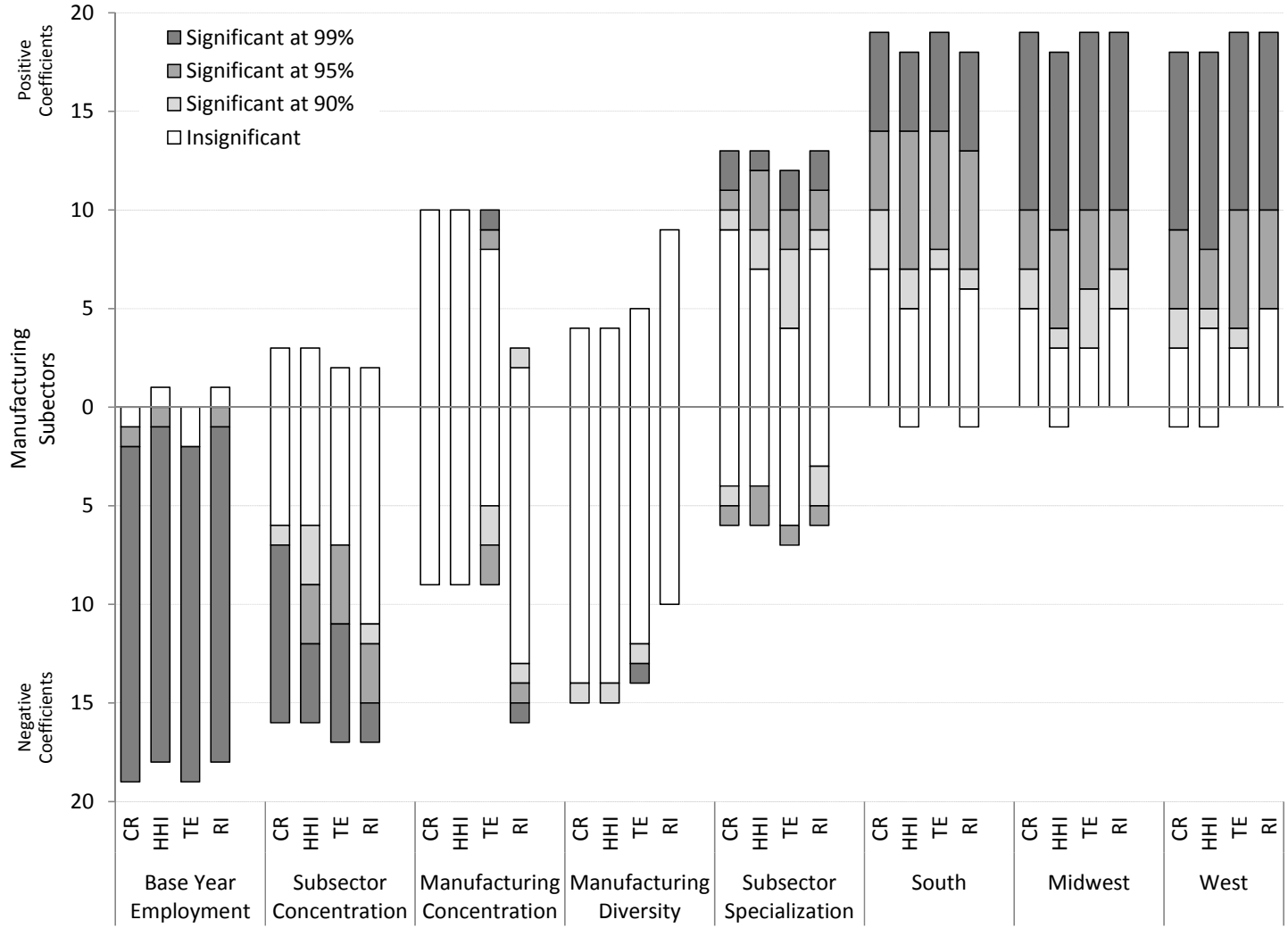


Figure Explanation: The columns count manufacturing subsectors (out of 19 total) classified by the sign and significance level of the estimated coefficients, for each of the independent variables listed across the horizontal axis and for each of the four concentration measures of competitive structure (CR = Concentration Ratio, HHI = Herfindahl-Hirschman Index, TE = Theil's Entropy, RI = Rosenbluth Index). Comparisons within grouped quadrads demonstrate the similarity of the results across competitive structure indicators; comparisons across quadrads reveal which variables consistently are significant and influential.