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Regional industrial structure and agglomeration economies: An analysis of productivity in three manufacturing industries☆

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ABSTRACT

We investigate whether a more concentrated regional industrial structure – the dominance of a few large firms in a given industry in a region – limits agglomeration economies and ultimately diminishes the economic performance of firms in that industry, especially small ones. In an application to three industries using establishment-level production functions and a combination of confidential and publicly available data sources, we find a consistently negative and substantial direct productivity effect associated with regional industrial structure concentration and only mixed and relatively weak evidence that agglomeration economies are a mediating factor in that effect.

1. Introduction

Small manufacturing plants located in regions where their own industry is dominated by a few large firms may be less able to capture the benefits of agglomeration economies than plants in regions with a less concentrated industrial structure. The reasons are several. First, a highly concentrated industrial structure implies a narrower range of local specialized producer inputs and services. Large firms are more likely to source inputs from nonlocal suppliers, either via internal supply (vertical integration) or national contracts, thus reducing the size of the local market for independent specialized suppliers (Enright, 1995; Porter, 1998; Henderson et al., 2001). When local suppliers are present, they may be functionally and strategically linked to a large local manufacturer; they may favor the stability of large volume contracts and therefore be less inclined to work with smaller producers; or they may generally be more responsive to the needs of producers with the most buying power (Nelson and Winter, 1982; Booth, 1986). Second, the most productive workers, particularly those with specialized skill sets and experience, may gravitate toward the largest and most stable employers, reducing labor pooling economies for the full range of producers in a region (Audretsch, 2001). Third, networking among firms may be lower where an industry's structure is highly concentrated, decreasing knowledge spillovers among firms in that local industry (Chinitz, 1961; Saxenian, 1994; Carree and Thurik, 1999; Scherer, 1980; Glaeser et al., 1992; Malmberg and Maskell, 2002).

Although empirical evidence of a link between local industrial structure and agglomeration economies does exist, most of it is indirect. There are a growing number of studies of the influence of industrial diversity and average establishment size on productivity, employment growth, innovation, and business start-ups (e.g., Quigley, 1998; Hanson, 2001; Dissart, 2003; Henderson, 2003; Glaeser and Kerr, 2009; Glaeser et al., 2010). However, cross-industry diversity is a different concept than own-industry structure and, since multi-establishment firms are common in any given location, average establishment size is only a rough indicator of industrial structure (Evans, 1986). Measuring regional industrial structure concentration is difficult because micro-level data are necessary to

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construct an appropriate firm-based indicator. Case studies of industrial structure in particular regions are suggestive but have limited generalizability (some examples are Scott, 1988; Saxenian, 1994; Enright, 1995; Rantisi, 2002; Watts et al., 2003). At the national rather than regional scale, empirical findings suggest that a concentrated industrial structure can affect firms' performance either negatively or positively, depending on the level of concentration (Caves and Barton, 1990; Nickell, 1996; Acs et al., 1999; Gopinath et al., 2004).

Two recent empirical studies examine the links between industrial structure and external economies directly. Feser (2002) includes the level of structural concentration in the manufacturing sector as a control in an establishment-level productivity analysis of spatially attenuating sources of agglomeration economies in two manufacturing sub-industries, finding a strong positive relationship between a competitive structure (lower concentration) and productivity in an innovation-intensive industry (measuring and controlling devices) but no significant association for a less technology-driven industry (farm and garden equipment). Rosenthal and Strange (2003) use micro-level data to calculate indicators of structure, regional cross-industry diversity, and concentric ring measures of localization and urbanization economies for six industries. They find that a higher share of regional industry employment in smaller establishments (or lower structural concentration, which they describe as an "entrepreneurial industrial system") is associated with more firm births and new-establishment employment. Both of these studies reveal a link between regional industrial structure concentration and economic outcomes. Yet Feser does not study industry-specific structure and neither Feser nor Rosenthal and Strange examine the intervening effect that structure may have on firms' realization of specific kinds of local external economies.

The hypothesis tested in this paper is that a higher level of concentration in an industry in a region – that is, the dominance of a few large firms – limits agglomeration economies and ultimately diminishes the economic performance of some firms in that industry, especially small ones. If true, an important implication is that the distribution across local enterprises of frequently postulated benefits of clusters, districts, and other forms of agglomeration is uneven, contingent on the specific structure of the industry in the place. Again, these ideas often have been tested directly in case studies and indirectly in studies of the influence of industrial diversity and average establishment size on various measures of firm or industry performance. Our objective is to construct a test of the hypothesis that measures the concept of industry-specific structure concentration more precisely. We do that by using a combination of confidential and publicly available data to estimate the productivity effects of local structure concentration in a given study industry, of spatially varying sources of agglomeration economies for that industry, and of interactions between structure concentration and the agglomeration economy sources. In application to three industries, we find a consistently negative and substantial direct productivity effect associated with industrial structure concentration and only mixed and relatively weak evidence that agglomeration economies are a mediating factor in that effect.

2. Empirical framework

A substantial body of empirical work investigates regional agglomeration economies with production functions (see the discussions in Eberts and McMillen, 1999; Rosenthal and Strange, 2004). Research conducted through the mid-1990s typically used publicly available regional- or state-level data to estimate aggregate industry production functions for selected Standard Industrial Classification (SIC) sectors. With better availability of micro-level data, plant-level estimation has largely supplanted the aggregate approach. At the micro-level scale, better capital data are available, aggregation bias is not an issue, the assumption of profit maximization is more reasonable, and intraregional spatial variation can be better incorporated. Micro-level studies of agglomeration economies generally have found substantial positive influences on productivity, though with much variation across agglomeration economy sources, industries, and establishment sizes (Malmberg et al., 2000; Feser, 2001, 2002; Rigby and Essletzbichler, 2002; Henderson, 2003).

Our establishment-level production function is

$$\begin{aligned}\ln Q = \alpha_0 &+ \textstyle\sum_i \alpha_i \ln X_i + \frac{1}{2}\sum_i \sum_j \beta_{ij}\left(\ln X_i \ln X_j\right) \\ &+ \textstyle\sum_k \gamma_k \ln Z_k + \sum_i \sum_k \mathrm{I}(i,k)\lambda_{ik} \ln X_i \ln Z_k \\ &+ \textstyle\sum_k \sum_l \mathrm{I}(k,l)\lambda_{kl} \ln Z_k \ln Z_l\end{aligned} \tag{1}$$

where Q is establishment output; X represents four conventional inputs (capital, labor, energy, and materials); Z is a vector of regional economic characteristics including industry-specific structure concentration and agglomeration economies; i and j index the inputs in X; and k and l index the components of Z. The two indicator functions permit selective inclusion of interaction terms: the first allows the variables in Z to enter the production function in factor-augmenting form; the second permits the square of structure concentration to be an independent variable and enables estimation of the indirect effect of concentration on productivity via agglomeration economy sources. The translog form of (1) avoids imposing strong a priori assumptions such as constant returns to scale. Following the inverse demand function methodology of Kim (1992), we jointly estimate cost share equations derived from first-order conditions, improving efficiency. The details of the cost share derivations are provided in Appendix A.

All non-dummy variables are mean-centered. Variables not measured as percentages or ratios are transformed with natural logarithms; the coefficient estimates are interpreted as elasticities at the sample means. Additive disturbance terms appended to the production function and cost share equations are assumed to follow a multivariate standard normal distribution. One cost share equation (energy) is dropped to avoid a singular covariance matrix and the system is estimated using iterated nonlinear seemingly unrelated regression (Zellner efficient estimation), allowing disturbances to be correlated across equations. The estimates are asymptotically equivalent to maximum likelihood estimates and are invariant to the choice of which cost share equation to omit (Greene, 2003).

We study three manufacturing industries chosen to satisfy several criteria: rubber and plastics (SIC 30), metalworking machinery (SIC 354), and measuring and controlling devices (SIC 382). Each has enough establishments spread across regions to present adequate variation in regional industrial structure concentration and sufficient observations to support the translog estimation system. The industries are flexible in location choice, relatively homogeneous in production technology, and contrast two traditional industries producing standardized products in a capital-intensive manner with a more technology-intensive industry (measuring and controlling devices) subject to shorter innovation cycles. The geographic regions are U.S. Department of Agriculture Labor Market Areas (LMAs) (2003), which approximate functional economic areas and cover the contiguous 48 states.

3. Data and variable construction

The principal data are confidential establishment-level records from the Census of Manufactures for 1992, 1997, and 2002, compiled in the Longitudinal Research Database (LRD) of the U.S. Census Bureau. We combine public data with conventional input, output, and cost share measures constructed from the LRD to create establishment- and regional-level indicator and control variables. Appendix B provides details.