Industry Clusters and Metropolitan Economic Growth and Equality

Jonathan Q. Morgan

School of Government
University of North Carolina at Chapel Hill

Abstract

Despite the recent popularity of industry clusters, we know very little about their influence on regional economic development outcomes. This article advances what we know by examining the extent to which industry clusters are associated with higher levels of economic growth and equality in metropolitan areas. The analysis focuses on the extent to which clusters affect typical economic development outcomes such as growth in employment and per capita income. Indicators of intra-regional economic equality are also included to determine the extent to which clusters can be utilized to achieve a broader set of economic development goals like regional equity and inner city prosperity. The relationship between clusters and economic growth and equality is estimated using bivariate correlation and multiple regression analysis of data for metropolitan statistical areas (MSAs) in the U.S. The findings suggest that the contribution of industry clusters to metropolitan economic performance is not automatic and that all clusters are not created equal in terms of their ability to bring about economic development.

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INTRODUCTION

This article examines the potential of industry clusters as an economic development strategy for metropolitan regions and their central cities. The cluster concept has become increasingly popular as a tool for localities and regions to use in understanding their economies and taking actions to become more competitive. According to Rosenfeld (2002), "conceptually, industry clusters have become the sine qua non[1] of economic development policy in many parts of the world" (p. 5). However, it is no new discovery that certain regions tend to specialize in particular industries. Whether it is automobile production in Detroit, software development in Silicon Valley, motion picture production and entertainment in Los Angeles, financial services in New York, or furniture manufacturing in High Point and Hickory, North Carolina, firms in certain industries display a propensity to locate in particular geographic areas. At least that much about industry clusters is obvious. What is less clear is the extent to which clusters make a tangible difference in terms of helping regions achieve desired economic development outcomes.

The beneficial effects of clusters are mostly taken for granted. Policy makers and practitioners assume that the promotion of clusters will result in improved local economic conditions. Empirical evidence demonstrating a strong link between clusters and regional economic performance has been tentative and inconclusive. Still, many jurisdictions continue to embrace and implement cluster-based policies. Given the widespread adoption of the cluster approach, it is important to document how regions can expect to benefit from the clustering phenomenon. As such, this article attempts to provide additional evidence on the association between industry

clusters and measurable indicators of economic development.

The research task at hand is complicated by the fact that the industry cluster paradigm suffers from inconsistent definitions, imprecise measurement, lack of empirical testing, and an unclear grounding in theory (Doeringer and Terkla 1995; Feser 1998a; Held 1996; Martin and Sunley 2003). Though to advance what we know about cluster-based development, we must continue trying to verify the theoretical benefits that clusters portend. This article does so by examining how industry clusters contribute to regional economic performance using data on metropolitan areas in the U.S. during the period from 1990-2000. The research contributes to the literature by examining the extent to which the economic performance of metropolitan regions in the U.S. varies in relation to the degree of specialization in certain industry sectors. Additionally, the research informs both theory and policy by identifying the particular industries for which cluster-based policies might be expected to contribute to regional economic development.

Following this introduction, the article reviews the literature pertinent to understanding the relationship between industry clusters and regional economic development. Drawing from the literature and previous research, the next section sets forth the analytical framework used to predict and examine how clusters might affect specific regional economic development outcomes. After explaining the study's research design and methods, I report the results of the statistical analysis. The article ends with a brief summary of the key findings and a discussion of their implications for theory and policy.

LITERATURE REVIEW

Clusters and Competitive Advantage

Hardly a novel idea, the cluster concept has intellectual roots dating back to British economist Alfred Marshall and his writings on industrial districts in the early 1900s.[2] Contemporary scholars and analysts like Michael Porter (1990) and Stuart Rosenfeld (1997) have expanded on Marshall's work to emphasize the importance of having specialized institutions and infrastructure to support the firms in a cluster. Others writers accentuate the supply chain linkages between firms across industry sectors (Feser and Bergman 2000). The socio-institutional, policy, and supply chain linkage dimensions of clusters are important, but only when a critical mass of firms exists in the first place. In other words, having a critical mass of firms is most often a precondition for a cluster to form and develop.[3]

Therefore, in the most basic sense**,** an industry cluster is a critical mass or geographic agglomeration of firms within a particular industry or group of related industries. Key advantages accrue to firms simply because they are located in close proximity to each other (Porter 2000). By "clustering" firms can enjoy cost savings and efficiencies arising from economies of scale. For example, firms in a cluster can increase their profitability by doing business with nearby firms and customers, thereby reducing transaction costs. Classical agglomeration theory refers to these advantages and cost savings as external localization economies (Malizia and Feser 1999; Feser 1998a; Maki and Lichty 2000). To understand the influence of industry clusters on economic development outcomes in terms of agglomeration requires a focus on these advantages that firms in spatially localized industries enjoy.

According to agglomeration theory, when related firms are in close proximity to each other they generate a competitive advantage from cost savings, productivity gains, knowledge spillovers, and increased access to specialized inputs like labor and technology (Feser 1998b). Over the past decade, a number of quantitative studies have sought to empirically verify the extent to which geographically proximate concentrations of related firms create the kinds of economic advantages suggested by agglomeration theory. These studies vary considerably in terms of the level of geography studied; specification of dependent variables measuring economic performance; indicators of clustering/industrial agglomeration used; and inclusion of other regional factors as control variables (Barkley et al. 1999; Kim 1998). While there is some overlap, the previous quantitative empirical research on the benefits of industry clusters can be divided into studies that examine:

1. The relative impact of *localization economies*, *competition*, and *urbanization economies* on firm and industry performance.

2. How industrial structure (e.g., specialization vs. diversity; small vs. large firms) affects the performance (employment growth, innovation level, labor productivity) of *individual industries* within a region.

3. How industrial agglomeration affects the performance (employment growth, income, wages) of *regions as a whole.*

The theoretical proposition that the clustering of economic activity in a place creates certain advantages that

benefit firms and industries has been examined extensively in the literature (items one and two above). Much of the previous research on the economic development impacts of industry clusters deals with the relative importance of localization and urbanization economies and local competition in stimulating growth (e.g., Henderson 1997; Glaeser et al. 1992; Henderson et al. 1995; Barkley et al. 1999). These studies examine how industrial agglomeration affects economic performance at the level of individual industries rather than at the aggregate regional level. Localization economies are the static cost savings and dynamic knowledge spillovers that firms within a single industry enjoy as a result of being in close proximity to one another.[4] Urbanization economies are the cost savings and knowledge spillovers that come about from increases in the scale of activity in a region. With urbanization economies, the breadth and diversity of economic activity in a place are the source of the positive externalities. Thus, firms across multiple industries will benefit from urbanization as the scale of economic activity and size of a place increase.[5]

This body of work focuses on industry level growth because it attempts to determine if, and which, industry sectors perform better under conditions of specialization or economic diversity. In these studies, localization effects are captured in measures of industrial concentration or specialization and urbanization effects are measured as the level of industrial diversity within a local economy. The findings from this research are mixed. Some studies confirm the importance of localization economies in enhancing the growth and performance of spatially concentrated industries (e.g., OhUallachain and Satterthwaite 1992; Barkley et al. 1999; Henry et al. 1997; Gabe 2003). Others find that urbanization economies are most critical to industry growth providing support for the

Jacobs (1969) diversity hypothesis (e.g., Glaeser et al. 1992; van Soest et al. 2002; Combes 2000). A general pattern in these empirical results is that traditional, mature manufacturing sectors tend to perform better when they are highly concentrated in an area while high technology and service sectors appear to thrive in economically diverse settings.[6]

In addition, some studies examine Porter's (1990) hypothesis regarding the role of intense local competition in enhancing the growth effects of intra-industry knowledge spillovers (van Soest et al. 2002; Glaeser et al. 1992). Both Romer (1986) and Porter (1990) predict that growth in an industry will increase as its level of concentration in a place increases. However, Porter argues that a competitive industrial environment is better than a monopolistic one because it results in more innovation and growth. Jacobs (1969, 1985) predicts that industrial diversity and competition are better for growth.

Specialization versus Diversity: A False Dichotomy?

The vigorous debate in the literature as to whether specialization or diversity is better for growth may rest on a false dichotomy between the two concepts. The general view is that specialization connotes a lack of economic diversity and vice versa. If so, then the promotion of industry clusters runs the risk of creating highly specialized local economies that have put all their proverbial eggs in one basket. If local economies are specialized in a single industry or only a few sectors, they are indeed more vulnerable to cyclical declines in those industries. However, another view suggests that specialization and diversity are not necessarily incompatible (Glasmeier 2000). Malizia and Feser (1999) define economic diversity as "the presence of multiple specializations" (p. 92). It is

possible then that local economies can be highly specialized in certain industries and at the same time possess a healthy mix of economic activities overall. Henderson (1997) provides some empirical support for this supposition and concludes that "to maintain strength in a particular industry a location wants concentration of employment in that industry, yet it also wants a surrounding diverse industrial base" (p. 469). As such, the current article is less concerned with addressing the relative importance of industrial specialization versus diversity in enhancing industry level growth. Rather the focus here is squarely on the potential influence of clusters (i.e. industrial concentration) on aggregate regional economic performance.

Direct and precise measurement of localization economies is methodologically complex and problematic and must be done at the individual industry or establishment level.[7] Since the current study is concerned with the relative performance of clustered regional economies at a macro-level, it does not seek to measure localization economies directly. Rather, it examines how metropolitan economic growth and equality vary in relation to the extent of industrial clustering or concentration in a region. The fundamental question is whether or not clustering makes not only firms and industries more competitive but the regions in which they are located as well. That is to say, do the localization economies that improve the performance of firms and industries, in turn, help regions create more jobs, raise income levels, and reduce economic disparities?

The Relationship between Industry Agglomeration and Regional Economic Performance

Theoretically, and to some extent empirically, it is apparent that the clustering of economic activity in a place creates certain advantages that benefit firms and groups of related firms in terms of enhanced growth. However, from a strategic public policy perspective, we need to know whether or not industry clusters make a positive difference for regional economic performance. If the promotion of clusters is to be a rational policy choice for cities and regions, then the benefits of clusters should somehow extend beyond firms and industries to measurably contribute to improved economic outcomes at the macro regional level. We now turn to the previous research on this specific question.

Only a few studies have examined the extent to which clusters contribute to macro-level regional performance. OhUallachain (1992) analyzed the relationship between economic structure and regional employment and income growth in the 150 largest metropolitan areas (SMSAs) in the U.S. The stated purposes of the study were "to determine the usefulness of industrial clusters in explaining metropolitan growth" and "identify those particular groupings that had the strongest effects"(p. 69). Using factor analysis, OhUallachain grouped two-digit industry sectors into geographic "clusters" based on the distribution of employment shares in each industry across metro areas. These clusters were included in the regression models as independent variables. The 1977-1986 growth rates for total employment and per capita personal income at the aggregate metro region level were included as dependent variables. The results revealed that five out of 18 clusters had a positive effect on both employment and per capita income growth. They were high-order services, high-tech

manufacturing, state and local government, textiles and construction, and insurance. The retail trade and recreation service clusters were notable among the clusters that were positively related to metro employment growth but unrelated to income growth.[8] The study concluded that industry clusters are good predictors of metropolitan employment and per capita income growth (OhUallachain, 1992, p. 83).

More recently, Porter (2003) examined the role of industry clusters in the U.S. economy during the period 1990 to 2000 as part of a larger study on the economic performance of regions. Using states in the U.S. as the primary unit of analysis, Porter derived 41 traded clusters comprised of multiple industries. He then applied these cluster definitions to Economic Areas (EAs) in the U.S. as designated by the Bureau of Economic Analysis. Porter does not directly measure localization economies and beneficial externalities. Rather he assumes they exist and can be implied from the tendency of certain industries to co-locate based on employment correlations across sectors. Neither does he attempt to measure linkages to supporting institutions though they are an explicit component of his conceptual definition of clusters. Nevertheless, this study by Porter is ambitious in scope and reveals additional insight into the relationship between clusters and regional economic performance. Porter's (2003) most relevant finding for our purposes here is that cluster strength, based on employment concentration, is a significant determinant of regional economic performance.

ANALYTICAL FRAMEWORK

There are different ways to conceptualize clusters, and they have implications for how to study the effects of clusters on regional economic performance. Gordon and

McCann (2000) provide a useful framework for specifying key dimensions of clusters. Based on their typology, we can conceive of clusters along a continuum, from a mere critical mass to supply chains to social networks. The simplest type of cluster requires only the existence of a geographically concentrated mass of firms that have common needs and operate on a sufficient scale to generate economic benefits. In a supply-chain cluster, firms engage in production-related business transactions with one another. A social-network type of cluster presumes some level of non-market collaboration among the firms in a cluster.

These cluster types are not necessarily mutually exclusive, although each emphasizes certain aspects of industrial clustering that may have different implications for economic development. They all provide a partial response to the question of what distinguishes a cluster from a group of firms that happen to be located near one another. They vary with respect to the nature and the extent of cluster relations, the level of interdependence, and the role of supporting institutions. Since the current study defines clusters as critical mass, a full explication of each type of cluster is not warranted here. Though much of the recent literature emphasizes production-related supply chain clusters (e.g., Feser and Bergman 2000) and social network-based clusters (e.g., Porter 1998; Rosenfeld 1996 ; Hendry et al. 1999; Molina-Morales 2005), for our purposes here, we assume that having a simple critical mass of firms in a particular industry is the starting point for these more advanced types of clusters.

Clusters as Critical Mass

In the pure agglomeration model, industry clusters are defined simply as a critical mass or geographic

agglomeration of firms within a particular industry or group of industries. The pure agglomeration model "presumes no form of co-operation between actors beyond what is in their individual interests in an atomized and competitive environment" (Gordon and McCann, 2000, p. 517). The model is based largely on Marshall's (1920) original concept of the industrial district with its emphasis on external localization economies. It gives prominence to the role of proximity, per se, in reducing costs and enhancing the efficiency of market transactions. In pure agglomeration clusters, relations between firms may not be identifiable given that "linkages are diffuse, unstable and not necessarily recognized even by the parties involved…" (Gordon and McCann, 2000, p. 529). Membership in the cluster is open to any firm in the local area due to the "absence of formal structures or strong long-term relations between businesses" (Gordon and McCann, 2000, p. 518). This critical mass of firms may constitute what Enright (2000) terms a "latent cluster" if it lacks the interaction and information flows needed to maximize the benefits of co-location.

The model of pure agglomeration is primarily concerned with the quantitative economic cost savings that are available to firms located in regional industry clusters. From this perspective, the geographic concentration of related firms in a particular place is sufficient alone to create direct economic benefits for both firms and industries. "The system is without any particular observable organization or interagent loyalty, and simply functions as an ecology of activities benefiting from proximity…" (Gordon and McCann, 2000, p. 517). That is to say, the external economies made possible by proximity are what make a cluster a cluster. Cluster firms may not necessarily transact business with each other. Synergy, in terms of a collective identity, interdependence and

collaborative activity, is not required to realize the economic advantages of clustering. Nor is any deliberate policy, strategy, or institutional framework needed to activate and engage regional clusters.

Agglomeration theory is not necessarily explicit in how industrial concentration might improve the performance of regional economies as a whole. However, it can be logically implied that the costs savings and efficiencies accruing to firms and industries within an agglomeration or cluster will result in improved macro-level economic outcomes. It seems that confirmation of this relationship is crucial for industry cluster theory and policy, given that the cluster approach has been touted as a highly effective economic development strategy and adopted by policy makers and practitioners around the world. If the benefits of clusters do not extend beyond the firm/industry level to the larger regional economy then the potential of cluster-based policies for achieving economic development is suspect.

As previously noted, relatively few prior quantitative studies have sought to determine if clusters actually create the kinds of economic advantages for regions implied by agglomeration theory that result in improved regional economic performance. Of the prior studies, the ones most relevant to the current study were conducted by Ohuallachain (1992, 1991) and Porter (2003). Ohuallachain (1992) found five clusters to be good predictors of growth in both metropolitan employment and per capita income between 1977 and 1986. Porter (2003) concluded that the strength of traded clusters strongly influences average regional wages during the period 1990 to 2000. These findings and, by implication, the tenets of agglomeration theory, suggest the following hypothesis:

H1: Regional industry clusters (levels of industrial concentration/specialization in a region) are positively associated with metropolitan economic development (aggregate employment growth, per capita income growth).

Unlike Porter (2003) and most others studying the effects of clusters, this article defines and measures metropolitan economic development in a way that captures not only aggregate regional economic growth but economic conditions in central cities relative to their surrounding suburbs as well. This focus on regional economic disparity is a distinctive empirical contribution to the cluster literature. By including indicators of regional economic equality, the study is able to determine what effect metropolitan industry clusters have on economic outcomes in central cities vis-à-vis their nearby suburban areas. This particular aspect of the research question derives more from public policy concerns than agglomeration/cluster theory per se. However, if we define economic development in this broader sense with a focus on how growth is distributed, it logically follows that clusters would be expected to improve the relative condition of central cities. In other words, if clusters are expected to enhance aggregate metropolitan economic performance, they should have a similar effect on central cities in terms of reducing economic disparities within regions. Empirically testing for this relationship sheds light on the usefulness of the industry cluster approach for creating inner city economic opportunity and facilitating regional prosperity that is widely shared.

In a recent article, Rosenfeld (2003) poses the question in this way: “Can clusters become equitable and just tools

for economic development or do cluster strategies skew resources to those already better off?" (p. 359). To get at this question, a second hypothesis is proposed:

> H2: Regional industry clusters (levels of industrial concentration/specialization in a region) are associated with greater economic equality (i.e. less disparity) between central cities and suburban areas.

If the cluster framework is to be relevant for inner city economic development it should be informed by recent research demonstrating that economic disparity between the central cities and suburbs tends to harm overall regional competitiveness (Wiewel and Schaffer 2001; Voith 1998). The usefulness of the cluster approach for inner city economic development lies in its ability to "recognize that issues concerning inner city development are central to, and not separate and apart from, issues concerning the development of metropolitan economies" (Robinson-Barnes, 1995, p. 128).

METHODS

The analysis employs bivariate correlation and multivariate regression analysis to test the hypothesis that metropolitan regions derive a competitive advantage from the presence and strength of their geographically concentrated industry clusters. This hypothesis is an outgrowth of agglomeration theory, which suggests that firms and industries will benefit from the agglomeration economies that clusters generate. I examine whether the external economies that create a competitive advantage for firms and industries located within clusters translate into improved regional economic outcomes. The hypothesis of a positive relationship between clusters and metropolitan

economic performance is tested to determine the extent to which variation in regional economic outcomes is explained by the level and type of industrial concentration in a region. In this section, I explain my use of the metropolitan region as a unit of analysis, describe the variables and their data sources, and briefly outline my approach to the statistical analysis.

The Metropolitan Region as a Unit of Analysis

The metropolitan region is the unit of analysis for this study. Data were compiled for all 317 Metropolitan Statistical Areas (MSAs) and Primary Metropolitan Statistical Areas (PMSAs) in the United States in 1990 as defined by the U.S. Office of Management and Budget. MSAs and PMSAs represent aggregations of counties based on population density and commuting patterns to the central cities in the region. In New England states, MSAs are comprised of cities and towns rather than counties. To be designated an MSA an urban region must include either one city with a minimum of 50,000 people or an urbanized area as defined by the U.S. Census Bureau and a total metropolitan population of at least 100,000.

Metropolitan regions are preferable as the unit of analysis for this study, because "unlike the nation, or census regions, or states or counties whose boundaries are administratively or politically determined, the definitions of (and the boundaries for) metropolitan areas are based on market or economic criteria" (Madden, 2000, p. 11). The delineation of multi-jurisdictional metropolitan regions acknowledges the economic interdependencies that cut across political and administrative boundaries. Barnes and Ledebur (1998) argue that metropolitan regions are "the basic economic units and the building blocks of the U.S. economy" (p. 20).

Dependent Variables

The variables for the quantitative analysis are derived from the two hypotheses regarding the relationship between industry clusters and urban economic development. (See Appendix A for a complete list of variables used in the statistical analysis.) Since the dependent variables in the quantitative analysis are continuous and based on metric data, ordinary least squares (OLS) multiple regression is used.

To test the hypothesis that regional industry clusters are associated with increased economic development, two dimensions of urban economic development are examined: metropolitan economic growth and economic disparity between central cities and suburbs. Metropolitan economic growth typically refers to the overall functioning of the urban economy and does not take into consideration the distribution of growth and related equity issues (Wolman 1987). In this study I use a broader definition of urban economic development that encompasses equity concerns. Therefore, I operationalize the concept by measuring both aggregate regional growth and intra-region economic disparity.

Metropolitan Economic Growth. There are a number of ways to measure metropolitan economic growth using secondary data sources (see Coomes 1998). Two widely accepted indicators of metropolitan economic growth are included as dependent variables. The first is EMPPCHG measured as the percent change in total employment from 1990 to 2000. The data for the employment growth variable were derived from employment numbers provided by the U.S. Bureau of Economic Analysis Regional Economic Information System. The second is PCINPCHG

measured as the percent change in real per capita income between 1990 and 2000. In contrast to Porter (2003), I use per capita income growth instead of average wage growth as a broader metric of economic performance. Per capita income data were compiled from metropolitan socioeconomic indicators downloaded from the Lewis Mumford Center for Comparative Urban and Regional Research web site at http://www.albany.edu/mumford. The Mumford Center data are derived from the decennial census.

Metropolitan Economic Disparity. The economic disparity between a metropolitan region's central city and suburban areas is included to capture the potential of industry clusters for achieving inner city economic development. Two indicators of economic disparity are included to test the hypothesis that metro regions with industry clusters will tend to have less disparity between their central cities and suburbs. The first is INCDISP measured as the ratio of central city per capita income to suburban per capita income in 2000. The second is HOMEDISP measured as the ratio of central city homeownership to suburban homeownership in 2000. The relative levels of per capita income and home ownership between the central city and suburbs are a good proxy for the distribution of wealth and economic prosperity within metropolitan regions. Data for these two variables were also obtained from data compiled by the Lewis Mumford Center for Comparative Urban and Regional Research.

Independent Variables

Regional Industry Clusters. To assess the relationship between industry clusters and metropolitan economic development requires determining which clusters exist in metropolitan regions. There are a variety of approaches to

measuring industry clusters for empirical purposes. Perhaps the most common and straightforward approach involves calculating a measure of relative concentration, called the location quotient, for individual industry sectors or groups of sectors thought to be related in some way[9] (Miller et al. 1991). The location quotient is an indicator of regional specialization. For this study, clusters are measured using two indicators: 1) the level of relative industrial concentration or location quotient based on employment, and 2) whether or not a region has an above average concentration of employment within a particular industry sector.[10]

The first cluster variable is a continuous variable measured as the level of industrial specialization in a region relative to the U.S. as a whole for an industry sector. The second cluster variable is a dummy (dichotomous) variable indicating whether or not a particular industry has attained sufficient critical mass to be considered a "cluster." A region qualifies as having a particular cluster if its level of employment concentration in an industry sector is "above average" i.e., at least 125 percent of the national concentration in that sector (i.e. if it has location quotient values exceeding 1.25).

Data for the cluster variables were compiled from the U.S. Census Bureau's County Business Patterns database. I calculated relative industry employment concentrations or location quotients at the two-digit SIC (Standard Industrial Classification) level for 28 industry sectors for all MSAs in 1990.[11] A relative measure of industrial employment concentration is preferable to absolute employment because it mitigates the bias in the data toward larger metropolitan regions (Ohuallachain 1991; Bergsman et al. 1972).

Control Variables

This study can be located within the broader literature that explains variation in regional economic performance, to the extent that it attempts to understand how one factor in particular—industry clusters—influences regional economic outcomes. Without question, there are multiple factors, in addition to clusters, that influence the economic development performance of regions. The most common factors analyzed in previous studies of the determinants of economic growth include: labor force characteristics, tax and fiscal policies, government spending, local development policies, and levels of social capital. In studies of industry cluster impacts, these factors are often included as control variables.

The literature suggests that a number of these variables should be included in the regression models to control for significant factors, other than clusters, that might influence metropolitan economic development. This study does not purport to propose a complex econometric model of regional growth that captures all possible factors contributing to variation in metropolitan economic performance. Rather, the study is primarily concerned with determining the relative importance of one variable in particular: industry clusters. To isolate the unique influence of clusters, I included the following explanatory variables in the regression analysis as controls:

- Population size and density
- Base-year economic conditions
- Workforce educational attainment
- Local tax revenues
- Local government expenditures
- Region of the U.S.

See Appendix B for a full description of each control variable and the justification for including it in the analysis.

Statistical Techniques

In the first part of the quantitative analysis, bivariate correlations were calculated using SPSS to examine associations between the industrial concentration and cluster dummy variables and the regional growth and equality variables. I then ran separate multiple regressions[12] for each of the 28 industries to see what happens to the relationship between industrial specialization and economic development after controlling for other selected factors that the literature suggests might influence economic performance. In this way, the importance of clusters relative to other variables can be assessed. In reporting and interpreting the correlation and regression results, I use significance levels as cutoff values for assessing the importance of observed statistical relationships. Since the data are not a random sample, statistical significance does not have the meaning it would in a study with random data. It is common practice in social science research to use significance levels in this way, with enumerated data, as arbitrary cutoff points in interpreting the importance of findings.

RESULTS

Agglomeration theory suggests that having a critical mass of firms in related industries creates economic benefits for those firms and industries. By extension, we can posit that the firm- and industry-level gains from clusters will result in higher levels of economic development for the regions in which clusters are located. Thus, regions with higher levels of industrial concentration

are expected to perform better in terms of economic development. For this study, economic development constitutes both economic growth and the equitable distribution of growth within a region.

In this section I examine the extent to which regional industry clusters contribute to measurable differences in economic development outcomes across metropolitan regions of the U.S. I present the findings from the correlation and regression analyses that show the statistical relationship between regional clusters and indicators of metropolitan economic development. The results for the association between clusters and metropolitan economic growth are presented first, followed by the findings for regional economic equality.

Clusters and Metropolitan Economic Growth

The first hypothesis tested is that regional industry clusters (levels of industrial specialization) are positively associated with metropolitan economic growth (aggregate employment growth, per capita income growth). Support for this hypothesis was modest at best and varied by type of industry. In fact, for a number of industries an inverse association with the economic performance variables was observed. Bivariate correlations between the two industry cluster variables and the two indicators of economic performance were calculated in SPSS. The bivariate correlations between each of the cluster variables and the two economic performance variables are shown respectively in Tables 1 and 2. Of the 28 industry sectors analyzed, 11 were found to have a statistically significant correlation between industrial specialization and either employment change or per capita income change. In only three sectors was the level of industrial concentration correlated with both employment change and per capita

income change: agricultural services, amusement and recreation services, and engineering and management services. This suggests that for some industries, the level of relative concentration in a region does indeed appear to influence metropolitan economic performance. However, the direction of the effect is not always in the positive direction as hypothesized.

Irrespective of whether the level of concentration is above average or not, higher relative employment concentrations were positively and significantly correlated with regional employment growth mostly in service sector industries. These include agricultural services, communications, business services, amusement and recreation, and engineering and management services. Amusement and recreation services had the strongest bivariate relationship overall with employment change in the positive direction. Higher employment concentrations within a number of manufacturing sectors such as rubber and plastics, primary metals, fabricated metals, and transportation equipment were negatively correlated with metropolitan employment growth between 1990 and 2000.

In terms of per capita income change, the bivariate correlations were positive and significant only for industrial machinery and health services. Negative and significant relationships were observed for agricultural services, amusement and recreation services, and engineering and management services. The relative level of employment concentration in amusement and recreation services exhibited the strongest bivariate correlation overall with per capita income, but in the negative direction.

When a concentration threshold for whether or not a region has reached sufficient critical mass within an industry is employed (cluster dummy variable) the bivariate

correlations show similar results. As shown in Table 2, clusters were significantly correlated with economic growth in metropolitan regions that have attained a critical mass within 12 of the 28 industries (i.e. location quotient of 1.25 or higher). The correlation results indicate that regions with the following industry clusters had higher employment growth between 1990 and 2000: agricultural services, business services, and amusement and recreation services. These results are consistent with Ohuallachain (1991) who also found a positive relationship between the business services and recreation services clusters and metropolitan employment growth. Lower employment growth was more likely in regions that were clustered in certain manufacturing industries including textile mills, rubber and plastics, primary metals, fabricated metals, and transportation equipment. In addition, the transportation services and health services clusters were negatively correlated with employment change.

Having attained critical mass was positively correlated with regional per capita income change for some industry sectors and negatively so for others. Table 2 shows that the clusters correlated with higher metropolitan income growth include primary metals, industrial machinery and computer equipment, and health services. Clusters associated with lower per capita income growth in metropolitan regions were mostly in service industries like agricultural services, transportation services, business services, and engineering and management services.

Table 1
Bivariate Correlation Results for
Industrial Specialization and Economic Growth Variables

SIC		Pearson r: Employment Percent Change	Pearson r: Per Capita Income Percent Change	N
07	Agricultural Services	.153*	-.335**	279
13	Oil and Gas Extraction	-.121	-.084	99
20	Food and Related Products	-.008	-.059	272
22	Textile Mill Products	-.108	.114	132
23	Apparel	-.111	.037	223
24	Lumber and Wood Products	.037	.034	253
25	Furniture and Fixtures	-.054	.020	217
28	Chemicals	-.085	.075	237
30	Rubber and Plastic Products	-.141*	.121	250
33	Primary Metal Industries	-.263**	.083	210
34	Fabricated Metal Products	-.253**	.075	272
35	Industrial Machinery	-.073	.209**	273
36	Electronic Equipment	-.052	.072	244
37	Transportation Equipment	-.140*	.046	236
38	Instruments and Medical Devices	-.110	-.046	219
42	Trucking and Warehousing	.013	.048	281
45	Air Transportation	.037	-.083	233
47	Transportation Services	.120	.010	246
48	Communications	.122*	-.033	281
50	Wholesale Trade - Durable Goods	-.021	-.013	281
51	Wholesale Trade – Nondurables	.008	-.054	281
62	Security and Commodity Brokers	-.104	-.113	222
63	Insurance Carriers	-.053	.045	277
67	Holding and Investment Offices	.055	-.040	211
73	Business Services	.194**	-.035	281
79	Amusement and Recreation Svcs.	.349**	-.165**	281
80	Health Services	-.079	.122*	281
87	Engineering and Management Services	.168**	-.148*	281

** Statistically significant at the 0.01 level
* Statistically significant at the 0.05 level

Table 2
Bivariate Correlation Results for
Cluster/Critical Mass and Economic Growth Variables

	Pearson r		
	Employment	Per Capita Income	
SIC	Percent Change	Percent Change	N
07 Agricultural Services	.242**	-.244**	279
13 Oil and Gas Extraction	-.016	-.045	99
20 Food and Related Products	.006	.033	272
22 Textile Mill Products	-.207*	.085	132
23 Apparel	-.086	.077	223
24 Lumber and Wood Products	-.008	.024	253
25 Furniture and Fixtures	-.082	.086	217
28 Chemicals	-.115	.092	237
30 Rubber and Plastic Products	-.142*	.081	250
33 Primary Metal Industries	-.276**	.140*	210
34 Fabricated Metal Products	-.239**	.059	272
35 Industrial Machinery	-.058	.150*	273
36 Electronic Equipment	-.067	.060	244
37 Transportation Equipment	-.135*	.044	236
38 Instruments and Medical Devices	-.036	-.006	219
42 Trucking and Warehousing	.026	.051	281
45 Air Transportation	.012	-.096	233
47 Transportation Services	-.100	-.140*	246
48 Communications	.077	-.009	281
50 Wholesale Trade - Durable Goods	.065	.035	281
51 Wholesale Trade - Nondurable Goods	.037	.005	281
62 Security and Commodity Brokers	-.106	-.015	222
63 Insurance Carriers	-.049	.092	277
67 Holding and Investment Offices	.072	-.061	211
73 Business Services	.123*	.002	281
79 Amusement and Recreation Services	.239**	-.118*	281
80 Health Services	-.131*	.139*	281
87 Engineering and Management Services	.104	-.155**	281

** Statistically significant at the 0.01 level
* Statistically significant at the 0.05 level

Multiple Regression Results for Economic Growth

Multiple regression helps determine if the relationships observed in the bivariate correlation analysis hold true after a number of other relevant factors thought to influence metropolitan economic development are taken into consideration (controlled for). Regression, then, enables us to ascertain the relative importance of industry clusters as a factor contributing to regional economic growth and equality.

The multiple regression analysis, with metropolitan employment percent change as the dependent variable, revealed statistically significant relationships for the industry sectors shown in Table 3. Regions with higher employment concentrations in textile mills and instruments in 1990 experienced less employment growth between 1990 and 2000. Conversely, higher employment concentrations in trucking and warehousing, transportation services, and amusement and recreation services, were associated with greater regional employment growth. However, having attained critical mass in certain industries in 1990 (employment concentrations of at least 125 percent of the national concentration) does not appear to appreciably influence employment change. The exceptions were agricultural services and transportation services. Above average concentrations in agricultural services were positively associated with metropolitan employment change while the opposite was true for transportation services.

The transportation services industry was positively associated with employment change in terms of industrial concentration, but negatively so for the cluster/critical mass variable. One interpretation for this seemingly

contradictory finding is that more of that particular industry is better for metropolitan employment growth up to a point. Once critical mass is attained in transportation services the positive influence on employment growth turns to negative. In other words, regions with employment concentrations in transportation services high enough to be considered "clusters" experienced lower employment growth than those beneath the critical mass threshold in that sector.

Table 3
Multivariate Regression Results for Metropolitan Employment Change
Standardized Betas for Statistically Significant Industries

	Industrial Concentration	Cluster (LQ>=1.25)
Agricultural Services	-.039	.154*
Textile Mill Products	-.156[a]	-.021
Instruments, Optical and Medical devices	-.175*	.096
Trucking and Warehousing	.200**	-.113
Transportation Services	.179**	-.156**
Amusement and Recreation Services	.296**	-.020

** Statistically significant at the .01 level
* Statistically significant at the .05 level
[a] Statistically significant at the .10 level

Even fewer industries had a statistically significant influence on metropolitan per capita income change in the multivariate regression models. These industries are shown in Table 4. The industrial concentration variable was negatively associated with metropolitan per capita income change for agricultural services. This indicates that regions with higher employment concentrations in agricultural services industries experienced lower levels of per capita income growth. Although having an agricultural services cluster (above average concentration) did not significantly influence per capita income change in one direction or the

other. The only other sector for which the industrial concentration variable affected metropolitan per capita income change was industrial machinery and computer equipment. Higher employment concentrations in this knowledge-intensive manufacturing industry were associated with higher per capita income growth. The cluster/critical mass variable for this industry had no statistically significant effect on per capita income change.

Two industry sectors were positively associated with metropolitan per capita income change based on the cluster/critical mass variable. These were primary metals, a manufacturing industry, and health services. Regions with employment concentrations above the national average in these industries in 1990 experienced greater change in per capita income between 1990 and 2000.

Table 4
Multivariate Regression Results for Metropolitan Per Capita Income Change
Standardized Betas for Statistically Significant Industries

	Industrial Concentration	**Cluster (LQ>=1.25)**
Agricultural Services	-.291**	-.017
Primary Metal Industries	.018	.176*
Industrial Machinery and Computers	.179*	-.068
Health Services	-.084	.163*

** Statistically significant at the .01 level
* Statistically significant at the .05 level

Influence of other Explanatory Variables on Metropolitan Economic Growth

This study is primarily concerned with determining if and how regional industry clusters contribute to urban economic development. The study is not designed to identify the optimal explanatory model of metropolitan economic growth. Thus the explanatory variables of most interest are the industrial concentration and cluster/critical mass variables. However, it is useful to report on the relative importance of the other variables included in the regression models.

As it turns out, the multivariate regression results showed that industry clusters are not necessarily the most important factors that contribute to metropolitan economic performance. Table 5 shows the standardized regression coefficients for the other explanatory variables included in the regression models for economic performance. Being located in the northeast region of the U.S. had the strongest effect on metropolitan employment change in the negative direction (b = –.451). This is consistent with the findings of Wolman (1987) and others regarding the relationship between regional location and metropolitan employment growth.

The next most important explanatory factor for employment change was the percent of the population with a college degree (b = .307). The positive sign for this coefficient suggests that a region's level of educational attainment is a significant predictor of employment growth. This is consistent with the findings of Bradley and Taylor (1996) and Wolman (1987) and provides support for human capital- and workforce-based approaches to economic development.[13] A metropolitan area's location in the

Midwest U.S. negatively affected metropolitan employment change (b = –.244).

The most important factor associated with metropolitan per capita income change was the proportion of a region's population with a college degree. Regions with higher levels of college educational attainment experienced higher per capita income growth during the study period. This is not surprising given the growing empirical evidence regarding the connection between education and income levels (see Gottlieb and Fogarty 1999). Moreover, this finding validates the growing recognition that workforce development is central to economic development efforts. The renewed interest in human capital and skills development is evident in the literature on clusters specifically (e.g. Feser 2003) and in the general literature of regional competitiveness (e.g. Florida 2002).

Table 5
Multivariate Regression Results for Metropolitan Economic Growth Variables - Standardized Betas Other Explanatory Variables

	Dependent Variables	
Independent Variables	**Employment Percent Change**	**Per Capita Income Percent Change**
Metro Population	-.022	-.191**
College Attainment	.307**	.321**
Initial Unemployment Rate	-.042	.069
Population Density	-.082	-.005
Tax Revenues Per Capita	-.040	-.104
Expenditures Per Capita	-.032	-.102
Northeastern Region of U.S.	-.451**	-.269**
Midwest Region of U.S.	-.244**	.135**
Western Region of U.S.	.058	-.234**
N = 281	R-square = .347	R-square = .310

** Statistically significant at the .01 level
* Statistically significant at the .05 level

Clusters and Intra-Region Economic Equality

The second hypothesis tested is that regional industry clusters (levels of industrial specialization) are positively associated with metropolitan economic equality (central city-to-suburb per capita income, central city-to-suburb home ownership) within regions. Empirical support for this hypothesis was mixed and varied by type of industry. The bivariate correlations between the industrial concentration and cluster dummy variables and the two economic equality variables are shown respectively in Tables 6 and 7.

Among U.S. metropolitan areas, greater parity in per capita income between the central city and suburbs was positively and significantly correlated with higher levels of employment concentration in nine of the 28 industry sectors studied. These industries were primarily traditional sectors including agricultural services, oil and gas extraction, food products, textile mills, apparel, and lumber. In addition, for two sectors related to distribution and logistics—transportation services and non-durable goods trade—higher employment concentration was positively correlated with greater intra-region per capita income equality. Based on the industrial concentration variable, the amusement and recreation services sector was also found to be positively and significantly correlated with per capita income equality. The oil and gas sector (r=.316) and the textile mill sector (r=.269) had the strongest positive correlation effects with city-to-suburban per capita income equality.

By contrast, metropolitan regions with higher employment concentrations in four particular industry sectors experienced less equality (i.e. greater disparity) between city and suburban per capita income levels. Three

of these sectors were in manufacturing: fabricated metal products (r=-.190), industrial machinery and computer equipment (r= -.181), and electronic equipment (r=-.142). The fourth was insurance carriers (r=-.179), which is a service sector.

The correlation results show that intra-regional equality in home ownership is positively and significantly correlated with higher metropolitan employment concentrations in lower skill, lower wage industries like agricultural services (r=.228), food products (r=.137), trucking and warehousing (r=.148), and amusement and recreation services (r=.172). Employment concentrations in a few higher paying, higher skill industry sectors were negatively correlated with home ownership equality. These sectors included electronic equipment (r=-.174), insurance carriers (r=-.133), and business services (r=-.133).

Table 6
Bivariate Correlation Results for
Industrial Specialization and Economic Equality Variables

	Pearson r		
SIC	City-to-Suburb Per Capita Income	City-to-Suburb Home Ownership	N
07 Agricultural Services	.121*	.228**	267
13 Oil and Gas Extraction	.316**	.195	92
20 Food and Related Products	.133*	.137*	265
22 Textile Mill Products	.269**	.042	127
23 Apparel	.196**	.019	217
24 Lumber and Wood Products	.136*	.002	245
25 Furniture and Fixtures	.120	.000	210
28 Chemicals	.055	-.032	228
30 Rubber and Plastic Products	-.109	-.055	239
33 Primary Metal Industries	.016	.091	204
34 Fabricated Metal Products	-.190**	-.028	260
35 Industrial Machinery	-.181**	.025	261
36 Electronic Equipment	-.142*	-.174**	236
37 Transportation Equipment	-.122	-.011	226
38 Instruments and Medical Devices	-.102	-.110	210
42 Trucking and Warehousing	.080	.148*	269
45 Air Transportation	.035	-.106	223
47 Transportation Services	.225**	.045	235
48 Communications	.037	-.112	269
50 Wholesale Trade - Durable Goods	.002	-.014	269
51 Wholesale Trade - Nondurable Goods	.169**	.067	269
62 Security and Commodity Brokers	-.131	-.125	214
63 Insurance Carriers	-.179**	-.133*	265
67 Holding and Investment Offices	.009	-.114	201
73 Business Services	-.085	-.133*	269
79 Amusement and Recreation Services	.130*	.172**	269
80 Health Services	-.010	.057	269
87 Engineering and Management Services	-.061	-.080	269

** Statistically significant at the 0.01 level
* Statistically significant at the 0.05 level

The findings from the correlation analysis regarding the relationship between the cluster/critical mass variable and economic equality are similar to those for the level of industrial concentration. As shown in Table 7, metropolitan regions with clusters in a number of manufacturing industries tended to have greater per capita income equality between central cities and suburbs. Most of these were traditional manufacturing sectors such as textile mills (r=.247), apparel (r=.146), food products (r=.124), and lumber and wood products (r=.173). The positive and significant correlation coefficients for these industry clusters suggest that they are associated with greater income equality within metropolitan regions. Two service industries were positively correlated with economic equality based on the cluster critical mass variable. These were transportation services (r=.142) and amusement and recreation services (r=.163).

Clusters associated with lower income equality (greater disparity) are those shown in Table 7 with negative correlation coefficients for city-to-suburb per capita income. These include manufacturing industries such as fabricated metals (r=-.226), industrial machinery and computer equipment, (r=-.131) and electronic equipment (r=-.138). Two of these industry sectors—industrial machinery and computers and electronic equipment—are typically considered to be more knowledge-intensive and pay relatively higher wages (see Appendix C). That they also appear to be correlated with greater income disparity is an interesting finding. The other two industries for which critical mass was positively correlated with per capita income equality were security and commodity brokers (r=-.141) and insurance carriers (r=-.200). These financial services industries are typically concentrated in larger metropolitan areas like New York City and Chicago.

In terms of home ownership equality within metropolitan regions, the divergence between the correlation effects of being clustered in traditional industries versus knowledge-intensive industries is even more apparent (see Table 7). Metropolitan regions with clusters of lower paying, traditional industries like agricultural services, food products, trucking and warehousing, and amusement and recreation services had greater parity in homeownership between central cities and suburbs. The negative correlation coefficients on the home ownership equality variable, shown in Table 7, for a number of knowledge-intensive industries indicate a wider gap between central city and suburban areas in regions with such clusters. These industries include chemicals (r = -.132), electronic equipment (r=-.128), and engineering and management services (r = -.169).

Table 7
Bivariate Correlation Results for
Industry Cluster/Critical Mass and Economic Equality Variables

	Pearson r		
SIC	City-to-Suburb Per Capita Income	City-to-Suburb Home Ownership	N
07 Agricultural Services	.112	.157**	267
13 Oil and Gas Extraction	.297**	.020	92
20 Food and Related Products	.124*	.163**	265
22 Textile Mill Products	.247**	.067	127
23 Apparel	.146*	-.021	217
24 Lumber and Wood Products	.173**	.044	245
25 Furniture and Fixtures	.044	.013	210
28 Chemicals	-.083	-.132*	228
30 Rubber and Plastic Products	-.077	-.030	239
33 Primary Metal Industries	-.091	.031	204
34 Fabricated Metal Products	-.226**	-.040	260
35 Industrial Machinery and Equip.	-.131*	.029	261
36 Electronic Equipment	-.138*	-.128*	236
37 Transportation Equipment	-.095	.058	226
38 Instruments and Medical Devices	-.091	-.056	210
42 Trucking and Warehousing	.065	.127*	269
45 Air Transportation	.037	-.158*	223
47 Transportation Services	.142*	-.042	235
48 Communications	.001	-.102	269
50 Wholesale Trade - Durable Goods	.002	.034	269
51 Wholesale Trade - Nondurable Goods	.097	.010	269
62 Security and Commodity Brokers	-.141*	-.147*	214
63 Insurance Carriers	-.200**	-.140*	265
67 Holding and Investment Offices	-.005	-.088	201
73 Business Services	-.013	-.158**	269
79 Amusement and Recreation Services	.163**	.204**	269
80 Health Services	.040	.033	269
87 Engineering and Management Services	-.072	-.169**	269

** Statistically significant at the 0.01 level * Significant at the 0.05 level

Multiple Regression Results for Economic Equality

The multivariate results for intra-regional economic equality were not as strong as they were for economic performance. The industry sectors found to be significantly associated with per capita income equality, after controlling for other factors, are shown in Table 8. Metropolitan employment concentrations in transportation services and durable goods trade were positively related to the ratio of central city-to-suburban per capita income within regions. That is to say, metro areas with higher concentrations of employment in these distribution-related industries had more income parity between their central cities and suburbs. However, the cluster/critical mass variable for these sectors showed no relationship with metropolitan income equality indicating that having concentration above the U.S. norm offered no additional advantage for income equality.

In the multivariate analysis, the cluster variable was inversely related to per capita income equality for three manufacturing industry sectors: chemicals, primary metals, and fabricated metals. Metro regions with above average concentrations or "clusters" of employment in these industries had less income equality (i.e. greater disparity) between their central cities and suburbs.

Table 8
Multivariate Regression Results for Metropolitan Per Capita Income Equality
Standardized Betas for Selected Industries

	Industrial Concentration	Cluster (LQ>=1.25)
Chemicals	.094	-.163*
Primary Metal Industries	.088	-.153*
Fabricated Metal Products	-.036	-.190*
Transportation Services	.150*	.081
Wholesale Trade-Nondurable Goods	.169*	-.083

* Statistically significant at the .05 level

Employment concentrations in only two of the industry sectors examined significantly influenced central city-to-suburban home ownership equality (see Table 9). The industrial concentration variable for engineering and management services, a knowledge-intensive sector, was positively related to the ratio of central city-to-suburban home ownership. For lumber and wood products, a traditional manufacturing sector, higher employment concentrations within a metro area were associated with less equality (i.e. greater disparity) in home ownership between central cities and suburbs. No significant relationship was found between the cluster/critical mass variable and home ownership equality for any of the industries studied.

Table 9
Multivariate Regression Results for Metropolitan Home Ownership Equality
Standardized Betas for Selected Industries

	Industrial Concentration	Cluster (LQ>=1.25)
Lumber and Wood Products	-.170*	-.012
Engineering and Management Svcs.	.174*	-.101

* Statistically significant at the .05 level

Influence of other Explanatory Variables on Metropolitan Economic Equality

As with metropolitan economic performance, industry clusters appear to be a less important factor for central city-to-suburb economic equality, than are a number of other variables. As shown in Table 10, regional location was the variable most strongly associated with per capita income equality after controlling for other factors including industrial concentration and the presence of a cluster/critical mass in a sector. The standardized coefficient of -.356 for the dummy variable representing location in the Northeast U.S. indicates a stronger effect on income equality than any of the concentration or cluster variables. The dummy variable for location in the Midwest U.S. has a beta weight of -.298. The negative signs for these two variables suggest that metropolitan regions located in the Northeast and Midwest tend to have less income equality (i.e. more disparity) between their central city and suburban areas. A similar inverse relationship is evident between the dummy variable for Northeast region and home ownership equality (b=-.292).

The variable with the strongest effect on the ratio of central city-to-suburban home ownership was college

educational attainment. It appears that metropolitan regions with a higher proportion of college graduates have less equality (i.e. greater disparity) in levels of home ownership between central city residents and suburban dwellers. The standardized regression coefficient for the college education variable of -.411 is a substantial effect size.

A metropolitan area's location in the Western region of the U.S. was positively related to parity in home ownership between the central city and suburb (b = .289). Levels of home ownership between central city and suburban dwellers were more equal in metropolitan areas located in the West. A metropolitan area's population density exhibited a similar positive effect on home ownership equality. Absolute population size was inversely related to home ownership equality.

Table 10
Multivariate Regression Results for Metropolitan Economic Equality Variables - Standardized Betas Other Explanatory Variables

	Dependent Variables	
Independent Variables	**Ratio of Central City-to-Suburban Per Capita Income**	**Ratio of Central City-to-Suburban Home Ownership**
Metro Population	-.038	-.172*
College Educational Attainment	-.076	-.411**
Initial Unemployment Rate	.071	-.079
Population Density	-.002	.207**
Tax Revenues Per Capita	-.073	.054
Expenditures Per Capita	-.081	-.050
Northeastern Region of U.S.	-.356**	-.292**
Midwest Region of U.S.	-.298**	.027
Western Region of U.S.	-.018	.289**
N = 269	R-square = .260	R-square = .293

** Statistically significant at the .01 level
* Statistically significant at the .05 level

SUMMARY

The quantitative relationship between clusters and metropolitan economic performance was modest but some patterns were evident. The effect of clusters was positive for some industries and negative for others (see Table 11). Manufacturing clusters, both in traditional and knowledge-intensive (new economy) industries, were negatively correlated with metropolitan employment growth. Two of the higher paying manufacturing clusters were associated with higher per capita income growth. Service industry clusters were generally better for metropolitan employment growth than for per capita income growth. Though two service clusters deviated from this tendency. The transportation services cluster was negatively associated with both employment and per capita income change. The health services cluster negatively influenced employment growth but exerted a positive influence on per capita income growth.

Table 11
Summary Findings for Economic Growth by Type of Industry
(includes only statistically significant sectors)

Industry Cluster/Critical Mass Dummy Variable	Employment Percent Change		Per Capita Income Percent Change	
	correlation	regression	correlation	regression
Traditional Manufacturing/Other				
Textile mill products	–			
Primary metals	–		+	+
Fabricated metal products	–			
Knowledge-Intensive Manufacturing				
Rubber and plastics	–			
Industrial machinery and computers			+	
Transportation equipment	–			
Traditional Services				
Agricultural services	+	+	–	
Transportation services	–	–	–	
Business services	+			
Amusement and recreation services	+		–	
Health services	–		+	+
Knowledge-Intensive Services				
Engineering and management services			–	

While regions clustered in traditional manufacturing industries experienced less employment growth they tended to have greater per capita income equality (i.e. less disparity) between their central cities and suburbs. As shown in Table 12, clusters in a number of traditional,

lower-wage manufacturing industries appear to be positively correlated with the ratio of central city-to-suburban per capita income. This suggests that traditional manufacturing clusters may be a drag on metropolitan employment growth but at the same time contribute to greater regional equality. Traditional manufacturing clusters appear to be bad for job growth but good for income equality. A possible explanation for this is that traditional manufacturing industries provide low- and mid-skill blue-collar jobs that tend to have an equalizing effect within a region. As regions transition from traditional manufacturing to higher skill, knowledge-intensive industries, the opportunities for lessening economic disparity are diminished to some extent. This is reflected in the findings summarized in Table 12 that knowledge-intensive industry clusters are inversely correlated to per capita income and home ownership equality. This implies that a possible downside of the new economy might be increased economic disparity.

Table 12
Summary Findings for Economic Equality
by Type of Industry

Industry Cluster/Critical Mass Dummy Variable	City-to-Suburban Per Capita Income		City-to-Suburban Home Ownership	
	correlation	regression	correlation	regression
Traditional Manufacturing/Other				
Oil and gas extraction	+			
Food products	+		+	
Textile mill products	+			
Apparel	+			
Lumber and wood products	+			
Primary metals		–		
Fabricated metal products	–	–		
Knowledge-Intensive Manufacturing				
Chemicals		–	–	
Industrial machinery and computers	–			
Electronic equipment	–		–	
Traditional Services				
Agricultural services			+	
Trucking and warehousing			+	
Transportation services	+			
Air transportation			–	
Amusement and recreation services	+		+	
Security and commodity brokers	–		–	
Insurance carriers	–		–	
Business services			–	
Knowledge-Intensive Services				
Engineering and management services			–	

IMPLICATIONS AND CONCLUSIONS

The clustering of firms in certain industries does indeed appear to matter for economic development both positively and negatively depending on the characteristics of the industry sector.[14] However, the strength of the statistical correlations is modest in most instances and the relationships diminish significantly in a multivariate context when other factors are controlled for. Relatively speaking, industry clusters, as measured here, seem to matter less for economic development than other factors. In particular, the results showed that a metropolitan area's level of educational attainment is a better predictor of regional economic growth than are industry clusters as defined in this study.

The results for economic equality were mixed but revealed a distinction between the effects of traditional clusters versus new economy clusters. Clusters of lower wage, traditional industries were positively associated with the economic equality variables. The positive effect on metropolitan per capita income equality was particularly notable. Traditional manufacturing clusters appear to be especially useful for reducing income inequality and the low-to-mid skill blue-collar jobs they provide appear to have an equalizing effect within a regional economy. As we transition away from traditional industries, and the jobs they provide for less skilled, less educated workers, toward a knowledge economy, we may lose opportunities for reducing economic disparities. This raises the real possibility that the new economy will exacerbate already existing inequities. That the new economy will likely worsen rather than mitigate economic inequality is due largely to the increasing returns that higher skilled

knowledge workers enjoy from their labor (Wheeler 2005; Nakamura 2000). Furthermore, it has been demonstrated that this wage-skills premium is more acute in metropolitan areas (Glaeser and Mare 2001; Wheeler 2005).

The findings reported here imply that the contribution of industry clusters to urban economic development is by no means automatic. The statistical analysis found only a modest relationship between certain clusters and increased regional economic growth and equality. Conversely, some clusters had a negative effect on these development indicators. The findings presented here suggest that the mere existence of a critical mass of firms in related industries does not guarantee better regional economic performance. Although critical mass likely creates advantages for firms and industries, the spillover to the region as a whole is not certain. This might mean that industrial concentration represents potential that is often untapped in the process of economic development.

This begs the question of whether it is agglomeration, per se, that matters or the socio-institutional factors within a region that accentuate the benefits of clustering that are most important. Perhaps having a critical mass of a certain type of industry is a precondition for a region to gain advantage from that industry cluster. Critical mass is likely a necessary but insufficient condition for a region to realize maximum benefits from industrial clustering. Could it be that critical mass is less important a factor than the deliberate institutional and policy mechanisms that a region puts in place to facilitate collaboration and strategically link its clusters to regional economic development needs?

For example, one of the strategic linkages that might help a region take better advantage of its industry clusters is a stronger nexus between clusters and workforce

development efforts. The relative importance of educational attainment as a positive influence on metropolitan economic growth found in this study points to the potentially crucial role of education and workforce development in cluster-based economic development strategies. Indeed, this emphasis on human capital and skills is reflected in a recent body of work on knowledge-based occupation clusters (Feser 2003) and the rise of the so-called "creative class" (Florida 2002).

A region's linkage and socio-institutional support mechanisms are dimensions of cluster-based development that cannot be adequately discerned in quantitative statistical analysis. So, the lack of a definitively robust quantitative relationship between clusters and economic development does not necessarily mean that clusters are less important than the literature suggests. It may merely reflect what analysts like Porter (1990, 1998) and Rosenfeld (1995, 1997) assert: that the most important aspects of cluster-based economic development are the social network, collaborative dimensions that are not readily apparent and quantifiable. From this perspective, the economic benefits of clusters are enhanced in those regions that not only have a critical mass within certain industries but that also deliberately work to create synergy and leverage the economic development potential that clusters represent. This aspect of industry clusters and their effect on economic development is a process question that warrants further research.

The ultimate research question in this article is whether or not industry clusters matter for economic development and, if so, how and why they do. The study finds that clusters probably do matter, but not necessarily in the ways suggested by much of the agglomeration literature. Agglomeration theory points to the external economies that

industries enjoy from being clustered together. Whether these benefits spill over to communities and regions is not explicitly addressed by agglomeration theory. The results reported here indicate that merely having an industry agglomeration or critical mass of firms does not inevitably translate into higher levels of economic growth and development. Critical mass is a necessary precondition for cluster-based economic development but, by itself, does not ensure a higher level of regional economic performance. This suggests that what a region does to leverage the potential of its concentrations of industry may matter more than simply having a critical mass of firms.

One implication of the findings is that industrial clustering may hold some promise, but is far from being a clear-cut magic bullet for economic development purposes. Industry cluster strategies will likely need to be nuanced to reflect the characteristics of target industries and particular economic development goals. Certain industries might be better candidates than others for cluster strategies if the goal is improving overall economic growth. If the goal is decreased economic disparity another set of industries might be more appropriate. The findings do not provide conclusive guidance for which clusters are better for particular economic development outcomes but some tentative conclusions can be inferred.

The success of a cluster strategy might depend on where target industries, and the goods and services they provide, are in their stage of development. This is consistent with the product/industry life cycle literature.[15] Being specialized in lower wage industries that are adding large numbers of jobs will likely spur a region's employment growth but inhibit per capita income growth. This was the case with amusement and recreation services, for example. Regions that are highly specialized in mature industries,

like textile mills, that produce commodity goods, which can be made more cheaply overseas, will tend to experience less employment growth. That is unless their economies are sufficiently diversified to offset the huge job losses occurring in many traditional industries.

The analysis revealed that some clusters are better for employment growth and others are more likely to influence per capita income growth. Clusters also varied in their effects on economic equality. These findings suggest that the appropriate policy question to ask is: which clusters for what purposes? It is prudent that policy makers be systematic in determining which clusters a region should target and why. It may not be sufficient to adopt a cluster-based approach to economic development without clearly specifying the intended outcomes of such a strategy. Policy makers must decide what they are trying to achieve and select clusters accordingly.

APPENDIX A
List of Variables in Statistical Analysis

EMPPCHG	Percent change in employment, 1990-2000
PCINPCHG	Percent change in real per capita income, 1990-2000
INCDISP	Ratio of central city-to-suburban per capita income, 2000
HOMEDISP	Ratio of central city-to-suburban home ownership rates, 2000
AGRISVCS, OILGAS, FOOD, TEXTILES, APPAREL, WOOD, FURNITUR, CHEMICAL, RUBBER, PRIMETAL, FABMETAL, MACHINES, ELECTRON, TRANSEQU, INSTRUM, TRUCKING, AIRTRANS, TRANSERV, COMMUNIC, DURABLES, NONDURABL, INVESTBR, INSURERS, HOLDINGC, BUSSVCS, AMUSE, HEALTH, ENGRMGMT	Industrial specialization in each of 28 industry sectors (location quotient), 1990
AGSVCLUS, OILGASCL, FOODCLUS, TEXTCLUS, APPCLUST, WOODCLUS, FURNCLUS, CHEMCLUS, RUBBCLUS, PRMETCLU, FABMCLUS, MACHCLUS, ELECLUST, TREQCLUS, INSTCLUS, TRUCKCLU, AIRCLUST, TRANSVCL, COMMCLUS, DURCLUST, NONDURCL, BROKCLUS, INSUCLUS, HOLDCLUS, BUSSVCSCLU, AMUSCLUS, HEALTHCL, ENGRCLUS	Cluster/critical mass dummy variable for each of 28 industry sectors, 1990

METROPOP	Metropolitan population, 2000
COLLEGE	Percent with bachelor's degree, 2000
UNEMPLOY	Unemployment rate, 1990
POPDENS	Metropolitan population per square mile, 1990
TAXESPC	Local tax revenue per capita, 1992
EXPENDPC	Local public expenditure per capita, 1992
NOREAST	Location in Northeast region of U.S.
MIDWEST	Location in Midwest region of U.S.
WEST	Location in West region of U.S.

APPENDIX B
Explanation of Control Variables

Population Size and Density. The literature suggests that larger urban areas will tend to have more economic activity and absolute growth by virtue of the urbanization economies generated from their size. In many studies, total population in an area and a measure of population density are included in regression models as control variables (Wolman 1987; Bradley and Taylor 1996; Olberding 2000). As such, two variables are included in the current analysis as indicators of population size and density. The first is METROPOP measured as the total number of residents in an MSA in 1990. The second is POPDENS measured as the total number of persons in an MSA per square mile in 1990. The data for the two variables were compiled from the U.S. Census Bureau.

Base-Year Economic Conditions. Since the performance of metropolitan regional economies can vary considerably at any point in time, it is important to control for economic conditions at the start of the study period, 1990. The literature suggests that base year economic conditions are likely to influence subsequent economic performance. According to cumulative causation theory,

the initial economic situation in a place has a snowball effect and will likely be perpetuated over time. As a result, market forces will tend to reinforce the trajectories of decline in lagging regions and continued prosperity in growing regions (Howland 1993; Malizia and Feser 1999; Olberding 2000). In essence, a region's starting point has a lot to do with where it ends up economically in relation to other regions. From this perspective, it is possible that regional differences in economic growth will be sustained or even worsen in the long-term.

To account for the influence of a metropolitan region's initial economic status, a variable UNEMPLOY, measured as the unemployment rate in 1990, is included in the regression models. The data for this variable come from the decennial census numbers compiled by the Lewis Mumford Center for Comparative Urban and Regional Research. These data are available for download from the Mumford Center web site at http://www.albany.edu/mumford.

Workforce Educational Attainment. Endogenous/new growth theory underscores the importance of knowledge and human capital in driving economic growth. Proponents of human capital-based economic development assert that regional growth is a direct function of the quality of the local human resource base, which is manifested in the education and skills levels of the workforce (Mathur 1999; Bradley and Taylor 1996; Fitzgerald 1993; Ranney and Betancur 1992). Several studies have empirically confirmed a strong positive relationship between human capital and economic development (Wolman 1987; Bradley and Taylor 1996; Pietrobelli 1998; Plummer and Taylor 2001b). Accordingly, I include a variable to control for regional differences in workforce capacity. The variable, COLLEGE, is an indicator of educational attainment in the

population measured as the percent of people aged 25 and over with at least a bachelor's degree in 2000. The data for this variable were compiled from metropolitan socioeconomic indicators produced by the Lewis Mumford Center for Comparative Urban and Regional Research. The Mumford Center data are derived from the decennial census.

Local Tax Revenues. Since taxes contribute to the cost of doing business, regions with higher relative tax burdens are thought to be less attractive to industry. In a summary review of research on the influence of taxes on state and local economic performance, Bartik (1992) found that taxes had a statistically significant negative effect on business activity in 40 out of 57 studies. Several previous studies of local economic performance include one or more indicators of the local tax burden as control variables in their regression analysis (Goss and Phillips 1999; Kim 2001; Olberding 2000). Accordingly, the variable TAXESPC or taxes per capita is included as a proxy for the metropolitan area tax burden. TAXESPC is measured as the total amount of general tax revenue collected by local governments in each region in 1992 divided by the total population in the MSA in the same year. The data for this variable came from the 2000 *County and City Extra* publication (Gaquin and DeBrandt 2000).

Local Government Expenditures. Many previous studies of the factors influencing economic development performance include indicators of the level of local government spending in core areas like education, transportation, and public safety (Wink and Eller 1998; Kim 2001; Olberding 2000). Spending on these local functions is thought to indirectly affect economic development outcomes. Some studies attempt to capture the level of local development effort more precisely by

including variables that measure actual spending on economic development or tax revenues forfeited through financial incentives (Wink and Eller 1998). It is reasonable to expect that variations in local government spending will influence economic development performance to some degree. Localities devoting more public resources directly to economic development and indirectly in core service areas should perform better generally. As such, I control for the level of local public expenditures by including the variable EXPENDPC, which is measured as the total direct general expenditure per capita in 1992. The data for this variable are based on summations of total spending by all local governments in each MSA. The data for all MSAs were compiled from the *2000 County and City Extra* publication (Gaquin and DeBrandt 2000).

Region of the U.S. Metropolitan areas are located in larger aggregated regions of the U.S. that experienced varying growth rates and economic conditions during the study period. The broader regional location of an area is included as a control variable in a number of pervious studies of economic performance (Ohuallachain 1991; Bradley and Taylor 1996; Olberding 2000; Kim 2001). Wolman (1987), in particular, found that an urban area's location in the Northeast and Midwest regions of the U.S. was the most important factor contributing to poor economic performance between 1970 and 1980. To control for macro regional location influences, three dummy variables are included that indicate whether or not an MSA is located in the Northeast (NOREAST), Midwest (MIDWEST), or West (WEST) U.S. census regions. If located in one of these regions, the MSA is assigned a score of 1. The south is excluded and serves as the reference region for the study.

APPENDIX C

Industry Wage Characteristics for Statistically Significant Industry Clusters

Selected Industries	Average Annual Pay, 2000	
	Pay	Low/High Wage
All private industries in U.S.	$35,337	
Traditional Manufacturing/Other		
Oil and gas extraction	$65,856	High
Food and related products	$35,164	Medium
Textile mill products	$29,050	Low
Apparel	$23,545	Low
Lumber and wood products	$29,181	Low
Primary metal industries	$45,124	High
Fabricated metal products	$37,799	High
Knowledge-Intensive Manufacturing		
Chemicals	$67,409	High
Rubber and plastics products	$35,137	Medium
Industrial machinery and computers	$53,838	High
Electronic equipment	$56,977	High
Transportation equipment	$53,303	High
Traditional Services		
Agricultural services	$20,355	Low
Trucking and warehousing	$32,626	Low
Transportation services	$35,387	Medium
Air transportation	$40,586	High
Amusement and recreation services	$23,579	Low
Security and commodity brokers	$151,786	High
Insurance carriers	$51,123	High
Business services	$36,192	High
Health services	$34,945	Medium
Knowledge-Intensive Services		
Engineering and management services	$55,022	High

Source: U.S. Bureau of Labor Statistics

NOTES

[1] Defined as something absolutely indispensable or essential.
[2] See Rocha (2004) for a comprehensive review of how the cluster concept has evolved over time.
[3] I acknowledge that there are more sophisticated ways to define an industry cluster. However, I assume that having a simple critical mass of firms in a particular industry is a starting point for more advanced types of clusters.
[4] Dynamic localization economies that come from increased specialization and knowledge spillovers between firms within an industry are often called MAR (Marshall-Arrow-Romer) externalities and are most recently reflected in the work of Romer (1986).
[5] The concept of dynamic urbanization economies is often referred to as Jacobs externalities and is attributed to Jane Jacobs (1969; 1985).
[6] See Henderson et al. (1995). They suggest that newer industries tend to thrive in large diverse metropolitan regions while mature industries do better in smaller, more specialized cities.
[7] See for example Nakamura (1985); Moomaw (1998); and Feser (2002).
[8] OhUallachain notes that the retail trade and recreation services sectors tend to create large numbers of lower wage jobs.
[9] The location quotient is a concentration index measured as the share of metropolitan industry employment divided by the national share of employment in the same industry. The conventional rule of thumb is that values greater than 1.0 indicate that an industry is over-represented in a region relative to the nation as a whole (see Miller, Gibson, and Wright 1991).
[10] There are limitations in using industrial concentration as an indicator for industry clusters. The level of industrial concentration does not gauge actual interdependencies or trading relations between firms and industries. It only provides evidence of the potential for such interdependencies. The inter-industry linkage dimension of clusters is not captured in individual industry location quotients. More complex quantitative techniques for identifying cluster linkages include graph theory analysis, network analysis, and statistical analysis of zero and rank order correlation coefficients between industries (Czamanski and DeAblas 1979). Statistical approaches often rely on factor analysis and hierarchical cluster analysis and are intended to measure the incidence of spatial concentration and linkage among related industries.

[11] Using the two-digit SIC level of industry detail is fairly common in studies of industrial agglomeration and specialization. See Mulligan and Schmidt (2005) for example.
[12] I conducted appropriate diagnostic tests to ensure that the data conform to the assumptions of regression analysis. These include linearity, normality, homoscedasticity, lack of outliers, and lack of extreme multicollinearity. The scatterplots of standardized residuals showed a roughly rectangular distribution indicating no violation of the linearity assumption. To test for normality, I inspected histograms and normal probability plots for each of the dependent variables and found no major deviations from normality. An examination of Mahalanobis distances revealed four cases that were outliers. Since regression is particularly sensitive to outliers, I considered dropping the extreme cases. To assess the possible effect of the outlier cases, I ran the statistical analysis a second time without the extreme cases. The results after dropping the outliers were similar to the first set of results. Therefore, the outlier cases were retained in the analysis.
[13] See Mathur (1999) for a treatise on the role of human capital in regional economic development.
[14] See Appendix C, which shows the wage characteristics and classification of industry sectors for which clustering was found to be significantly related to metropolitan economic development.
[15] See Sternberg 1996; Malizia and Feser 1999; Plummer and Taylor 2001a.

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AUTHOR BIO

Jonathan Q. Morgan is an Assistant Professor of Public Administration in the School of Government at the University of North Carolina at Chapel Hill where he specializes in economic development.

Prior to joining the School of Government, Jonathan worked for Regional Technology Strategies, Inc., an economic and workforce development consulting firm located in Carrboro-Chapel Hill, NC. He has also served as director of economic policy and research for the NC Department of Commerce, as well as research and policy director for the NC Institute of Minority Economic Development. Currently, Jonathan serves as course director for the annual Basic Economic Development Course. He is a member of the NC Economic Developers Association, ACCRA–The Council for Community and Economic Research, and the International Economic Development Council. He holds a B.A. from the University of Virginia, an M.P.A. from Clark Atlanta University, and a Ph.D. in public administration from North Carolina State University.

CONTACT INFORMATION

Jonathan Q. Morgan, Ph.D.
Assistant Professor
School of Government
University of North Carolina at Chapel Hill
CB# 3330, Knapp-Sanders Bldg
Chapel Hill, NC 27599-3330
919-843-0972
morgan@sog.unc.edu