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Innovative Metropolitan
Areas in the South:
How Competitive are South Carolina's Cities?

by

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INNOVATIVE METROPOLITAN AREAS IN THE SOUTH: HOW COMPETITIVE ARE SOUTH CAROLINA'S CITIES?

Introduction

Robert Atkinson (2004, p. 98) proposed that America's economy has entered a new 'long-wave' cycle "fueled by a new technology system based largely on information technology." This New Economy is characterized by greater global competition, new technologies and production practices, and enhanced roles for innovation and entrepreneurship. Under the evolving economic paradigm, innovative businesses and communities with environments conducive to adaptation are likely to prosper. Alternatively, economic growth and development prospects are more limited in communities with traditional businesses and fewer resources or less flexibility to change (Porter, et al., 2004).

Public policy recommendations to boost productivity and enhance competitiveness in the New Economy include: (1) encourage R&D and technological change, (2) facilitate transformation to a digital economy, (3) improve education and skills, and (4) promote entrepreneurship (Atkinson, 2004, p. 267). At the local level, state and community leaders are working with existing or emerging industry clusters to foster the development of "regional innovation systems" within which existing businesses become more competitive and new business start-ups are the result of significant innovation and entrepreneurial activity. Thus, competition among states and metro areas for economic activity is changing to include significant public and private commitments to attract or nurture clusters of innovation. Examples of state and local initiatives to develop clusters of innovation are Florida's Scripps Institute East Coast research facility, Missouri's Stowers Institute for Medical Research, and Arizona's Translational Genomics Research Institute (see table 1).

The principal goal of programs like those provided in table 1 is the creation of a geographic concentration of innovative activity that will enhance area economic development prospects through knowledge spillovers, product development, and new firm spin-offs. That is, a region's prospects for endogenous development are anticipated to improve significantly if regional innovative capacity is increased to the extent that the region is recognized as a "Regional Innovation System" or "Center/Cluster of Innovative Activity." Support for this approach is provided by Audretsh (2002, p. 77) who proposed that "the comparative advantage of the high-cost countries of North America and Western Europe is increasingly based on knowledge-driven innovative activity." In addition, Riddel and Schwer (2003, p.83) found "strong evidence of endogeneity between (state) employment growth and innovative capacity." Finally, Acs (2002, p. 187) concluded that "Globalization has rendered the comparative advantage in traditional moderate technology industries incompatible with high wage levels. At the same time, the emerging comparative advantage that is compatible with high wage levels is based on innovative activity."

The importance of innovation and entrepreneurial activity for local and state economic development is recognized in South Carolina's long-term economic strategy. The South Carolina Competitiveness Initiative (Porter 2005, p. 12) suggested that "South Carolina will be most successful by considering new ideas and innovations, and executing them." Yet critical to expanding innovation output is a regional business environment characterized by educated and skilled labor, basic research, infrastructure, capital, and related and supporting industries tailored to the needs of the local industry (Porter 2005, p. 19). Thus, South Carolina's strategic plan calls for increased innovative activity focused on existing and emerging industry clusters.

The purpose of this paper is to assess the innovative and entrepreneurial environments of South Carolina's metropolitan areas relative to metropolitan areas in the South. South Carolina's cities compete with Southern (and non-Southern) metro areas for innovative and entrepreneurial activity. A comparison of innovative/entrepreneurial environments across Southern cities enables us to identify areas of relative strengths and weaknesses in South Carolina's metro areas and target public policies at deficiencies in these environments.

The paper is organized as follows. First, metropolitan areas in the South are grouped according to their innovative activity based on 20 recognized measures of innovation capacity and entrepreneurial potential.¹ The selected characteristics reflect innovation in traditional industries as well as in the "high tech" and "information and communication technology" sectors so that the focus is on the innovativeness of the region's production processes and not on the area's industrial composition or product types. Cluster analysis is used to group the 107 Southern metro areas into 6 "groupings" with similar innovative environments. Second, the changes in economic activity of the metro areas are compared across the 6 cluster types. Measures of nonmetro county economic development are the 1900-2000 growth rates in population, employment and earnings per worker. Third, innovative measures for South Carolina metropolitan areas are compared to those of other metro areas in the South. Our findings indicate that South Carolina's metro areas generally rank in the top one-half in terms of measures of innovation; however, significant gaps exist between the South Carolina cities and the leading Southern metro areas. South Carolina's cities will need to markedly increase their innovative resources and activity to be recognized as leaders in the New Economy.

Identification of Regional Innovation Systems in the South

Indicators of Innovation. Attempts to identify and rank regions based on their competitiveness or innovative activity have been popular in the recent literature (Acs, 2002).² Measures of innovative activity used in earlier research fell into five principal categories: human capital or composition of the local labor force (e.g., degrees granted in science and engineering); volume of research activity (e.g., academic research and development expenditures); business start-ups and small business growth (e.g., jobs in “Gazelle” firms); regional industrial composition (e.g., jobs in high-tech industries); and productivity or competitiveness of basic sectors (e.g., export rank). The measures selected varied according to the focus of the study and availability of data by region type.

For this study, we initially selected 20 indicators of innovation and entrepreneurial activity at the county or metropolitan level. A list of the innovation indicators and their definitions is provided in table 2. The reader should note that all indicators were expressed in relative terms (e.g., venture capital investments per capita or employment in high technology industries as a percentage of total employment) to control for size differences among the Southern metro areas. The selected indicators, with the exceptions of INC 500 companies (1990-2000) and Patents (1995-1999), were measured using data sources for 2000 or 1998-2000. Thus, the indicators represented the innovative environments that evolved in metro areas over the 1990s. In addition, the use of data from the year 2000 permitted us to include innovation measures (e.g., venture capital) that were not available for 1990.³

One set of indicators reflected the relative *capacity for and volume of innovative*

activity in metro areas. Measures of university research included academic research and development expenditures per capita, number of science graduate students per 1000 population, and the number of science and engineering doctorates awarded per 1000 population. In addition, the data on science and engineering students reflected potential flows to the local pools of educated and trained individuals that Feller (2004, p. 144) argued was “the primary contribution that universities make to technology-based economic growth...” A measure for private or industry R&D was not available at the county or metro level. As a proxy for industrial R&D activity, we used the percentage of the MSA labor force in technical professions (defined as computer scientists; natural, physical, and social scientists; and engineers, except civil). Finally, following Acs, Anselin, and Varga (2002), we selected patents issued 1995-1999 per 1000 population as a measure of knowledge output or innovative activity.

The second element of a regional system of innovation is an *entrepreneurial environment* that enhances inter-firm networking in innovation (CHI Research Inc., 2004) and provides the “knowledge filter” through which innovation is transformed into commercialized economic knowledge and endogenous regional economic growth (Acs, Audretsh, Braunorhjem, and Carlsson, 2003). Feldman and Francis (2004, p. 131) proposed that “Innovation without entrepreneurship cannot result in regional development.” Proxy variables selected for entrepreneurial environment were percentage of establishments with fewer than 20 employees; percentage change in number of establishments 1999-2000; the number of rapidly growing small businesses companies (Inc. 500 companies, 1990-2000) per 100,000 population; and venture capital investments per capita in 2000. In addition, the percentage of employment in managerial and business professions and the percentages of

metropolitan establishments and employment in business services (SIC 73) were included as external sources of knowledge and information for entrepreneurs and small businesses.

Simmie (2003, p. 612) noted that “concentrations of business services... provide the marketing and commercial knowledge necessary for the introduction of innovations onto the market.”

Local labor force quality and human capital were represented by the percentage of the metro population (25 years old and older) that were high school graduates or college graduates in 2000. The percentage of the metro population of working age (16-64) was included as a proxy for overall labor availability. Glaeser and Saiz (2003) found a strong positive relationship between the skill composition of the local labor force and urban growth. They concluded that a skilled labor force increased productivity at the metropolitan level and enhanced the area’s capacity to adapt to new technologies and change from one field of specialization to another.

Acs (2002) found that innovative activity was concentrated in the *high technology industries*. The percentages of MSA employment in high technology and information technology industries and the percentages of establishments in high technology and information technology industries were selected to capture potential localization economies in these sectors (Feldman and Florida, 1994).⁴ Both employment and establishments were measured to differentiate metro areas with a few large establishments from those with numerous small high-tech or I-tech firms. Acs, Audretsch, and Feldman (1994) found that the smaller high technology firms tended to be the most innovative.

Finally, 1999 exports per capita for the metropolitan areas represented linkages to external markets and *competitiveness in the global economy*. Simmie (2003) suggested that

for high tech firms, international customers are an important source of external knowledge.

Cluster Analysis. Earlier research used the selected measures of an innovative environment to develop indices or report cards for states and metropolitan areas (see endnote 2). A metro area's "ranking" or "grade" in an index or report card is sensitive to: (1) the weights placed on the indicators (including unweighted or equal weights), (2) double counting from the inclusion of multiple indicators that are highly correlated, and (3) the "averaging out" of low and high indicator values. An alternative methodology for categorizing innovative activity in metropolitan areas is provided by cluster analysis. Cluster analysis is a statistical procedure that groups entities into relatively homogenous groups based on shared similarities among the provided characteristics. The procedure minimizes within group differences while maximizing between group differences. The groupings are not affected by weights or the inclusion of highly correlated variables. More importantly, metro areas with high values for some indicators and low values for others would not be treated as similar to areas with average values for most of their indicators. The cluster analysis would place the two different types of metro areas in different groupings. In sum, the cluster analysis approach used in this paper provides the opportunity to test the innovation - - economic growth relationship when innovation is defined broadly to capture innovative activity in both traditional and high technology sectors.

Metro Groupings. The initial cluster analysis of the 117 Southern metro areas (1990 designations) identified 3 clusters that included only 5 of the MSAs.⁵ Specifically, Atlanta and Raleigh-Durham-Chapel Hill (R/D/CH) were grouped in a cluster characterized by high values in all innovation measures except percentage of establishments with fewer than 20

employees. A second cluster contained only the Baton Rouge and Austin metro areas. This cluster was similar to the Atlanta-R/D/CH cluster in values for innovation measures except that the Baton Rouge/Austin cluster had higher high-tech employment and patents per 1000 population but lower relative values of venture capital and business services employment and establishments. Thus, Austin and Baton Rouge had significant innovative activity but lacked the supporting business services of the larger metropolitan areas of Atlanta and R/D/CH. Finally, Miami was a cluster unto itself, primarily because the business services (SIC 73) establishments and employment values that were over 4.5 standard deviations above the southern metro mean values. The values of Miami's other measures of innovative activity were close to the southern metro averages.

The cluster analysis was conducted a second time with the 5 MSA "outliers" removed from the data set. The remaining 112 southern metropolitan areas were divided into 5 cluster groupings hereafter referred to as High, College Towns, Medium, Below Average, and Low. The four outlier metropolitan areas (Atlanta, Austin, R/D/CH, and Baton Rouge) were grouped together in a sixth cluster named "Outliers." Table 3 lists the metro areas in each group, and table 4 provides the means of innovation and entrepreneurship indicator values for each cluster grouping.⁶

For the purpose of later discussion, we defined the metro areas in the Outlier, High, and College Town clusters as "regional innovation systems (RIS)" based on the generally higher values for the indicators of innovation and entrepreneurial activity. The cluster analysis indicates, however, that the three RIS groupings had different characteristics. The "outliers" are home to major research universities and three of the four "outlier" RIS (Atlanta, Austin, and R/D/CH) were included in the top 5 of the Forbes 2004 Best Places for

Business. The 12 “High” RIS are a mix of some of the larger MSA’s in the South (Dallas-Fort Worth, Houston, Tampa, etc.) and metro areas with large NASA facilities (Huntsville, AL; Melbourne-Titusville-Palm Bay, FL). Wilkerson (2002) also found that high-tech occupations in the Plains and Mountain states were concentrated in the larger cities and metro areas with government military-related research institutions. The MSAs in the High grouping had, on average, relatively high levels of employment in technical professions (our proxy for private R & D), venture capital per capita, business services, and high tech employment shares. Alternatively, academic R & D expenditures and average labor quality (as reflected in high school and college graduates) were lower than those in the Outliers and College Town clusters.

The remaining RIS in the South are 5 college towns that are home to large public research universities (Universities of Georgia, Florida, and Virginia; Texas A&M University; and Florida State University). College Towns, as expected, had relatively high values for academic R & D expenditures, college graduates, and high tech establishments. On the other hand, College Towns had relatively low high tech employment, business services employment, Inc. 500 companies, and churning of establishments. It appears that the entrepreneurial support systems in College Towns were not as well developed as those in the Outlier and High RIS.

The Medium cluster consisted of 20 mid-sized to large southern MSAs. Most of the members of the Medium cluster had large public or private universities (e.g., University of Kentucky in Lexington and Vanderbilt University in Nashville) that served as the academic R&D centers. The cluster members also had relatively strong export activity and employment in high technology industries. However, high tech establishments, innovative

activity (e.g., patents and private R & D), and venture capital support were relatively low for MSAs in the Medium grouping. The members of the Medium cluster may become RIS if the rate of innovation accelerates in the future.

The ‘Below Average’ and ‘Low’ clusters consisted primarily of smaller MSA’s with tourism/retirement (Myrtle Beach, SC), traditional manufacturing (Danville, VA), or gas/oil (Odessa-Midland, TX) as the principal basic industries. Many of the cities in the ‘Below Average’ and ‘Low’ clusters were characterized by Siegel and Waxman (2001) as ‘Third-tier Cities.’ Siegel and Waxman (p. 11) noted six challenges affecting the ability of these cities to prosper in the New Economy: out-of-date infrastructure, dependence on traditional industries, need to transform human capital, declining competitiveness within their regions, weakened civic infrastructure and capacity, and limited access to resources.⁷

In summary, relatively few of the 117 metropolitan areas in the South were classified as RIS (17 MSAs in the Outlier, High, and College Town groupings) or emerging innovation systems (20 MSAs in the Medium cluster grouping). These findings were not unexpected. Morgan (2004) noted that RIS are not commonplace because there are not many regions that offer the innovative firms and institutions, agglomeration benefits, and skilled labor force necessary to evolve into an innovation system.

South Carolina Cities. Eight South Carolina metropolitan areas (or areas shared with neighboring states) were included in the cluster analysis (Aiken-Augusta, Charlotte-Gastonia-Rock Hill, Charleston, Columbia, Florence, Greenville-Spartanburg-Anderson, Myrtle Beach, Sumter). All of the state’s metro areas except Florence, Myrtle Beach, and Sumter were placed in the ‘Medium’ grouping. Cities in the Medium group generally were among the South’s larger metropolitan areas (indicating a diversity of economic activity) and

had large public or private universities. Thus, these Southern metro areas have good foundations upon which to generate and support innovative activity. However, the Median group, on average, markedly lagged the Outliers, High, and College Town group in terms of innovative activity (as reflected in patents and employment in technical professions) and a supportive environment for entrepreneurs (as measured by availability of venture capital and business services).

The Florence, Sumter, and Myrtle Beach metropolitan areas were placed in the “Below Average” grouping. This grouping consisted primarily of relatively small metro areas with little research activity, few college graduates in the work force, and an unfavorable environment for entrepreneurs based on the availability of venture capital, business services, and managerial and business professions. On average, cities in the Below Average grouping need significant improvements in virtually all indicators of innovation to be considered emerging centers of innovation.

Innovation and Area Development

Metro Areas. The association between innovative activity and aggregate area economic development was investigated by comparing cluster values for 1990 to 2000 percentage changes in metro area population, employment, and earnings per worker (table 5). The findings of this research are consistent with earlier studies (Acs, 2002; Advanced Research Technologies, 2005) that found a positive relationship between an area’s innovative capacity and activity and its rate of economic development. Specifically, the “Outliers” cluster exhibited markedly higher growth rates in population, employment and earnings than any of the remaining 5 cluster groupings. In addition, there generally was a consistent

positive relationship between the indicator values for innovative environment and the measures of area growth. On average, the metro areas in the “High” and “College Town” clusters outperformed the cities in the “Medium” cluster which in turn outperformed the metro areas in the “Below Average” and “Low” clusters. The only exception to the above pattern was for the percentage change in earnings per worker by place of work. For this measure of economic activity, MSAs in the Medium cluster had a higher average growth rate than metro areas in the High and College Town Clusters.⁸

Nonmetro Areas. The findings for nonmetro counties in the labor market areas of the metro counties are presented in part B of table 5. The labor market areas (LMAs) used in this paper were developed by Tolbert and Sizer (1996) to identify the multi-county metro and nonmetro geographic areas that captured economically dependent counties based on commuting date. Among the Southern nonmetro counties, 588 counties (and Virginia cities) were assigned to LMAs with a metro core while 349 counties were members of rural labor market areas.⁹

The nonmetro counties followed a pattern similar to that of the metro areas in their LMAs. Specifically, nonmetro counties proximate to a RIS exhibited more rapid growth in population, employment, and earnings per resident. These findings support the hypothesis of a metro-to-nonmetro spread or spillover of population and jobs resulting from innovative activity in the RIS of the metro cores. There were, however, two minor differences between our findings for metro and nonmetro counties in the LMAs in the cluster groupings. First, the association between innovative activity in the metro area and nonmetro economic growth was not perfectly consistent. The nonmetro counties in the “Rural LMAs” and “Low” cluster groupings exhibited more rapid population, employment, and earnings growth, on average,

than the nonmetro counties in the “Below Average” cluster grouping. Second, the mean population, employment, and earnings growth rates in the nonmetro counties consistently lagged those of metro counties in the same cluster grouping. Thus, while evidence of urban-to-rural spillovers was present, these spillovers were not sufficient so that the economic growth in the nonmetro counties was similar to growth in the LMA’s metropolitan counties.

How Competitive are South Carolina Cities?

In the New Economy, the key drivers of local economic growth are (1) research and development that lead to new products and production processes (Atkinson, 2004); (2) an entrepreneurial environment that helps transform innovation into new businesses and jobs (Acs, 2002); and (3) an educated labor force that adapts quickly to changes in technological and market forces (Glaeser and Saiz, 2003). Communities that rank high in these three attributes are likely to be successful at generating new local economic activities as well as attracting businesses and labor away from other communities. Alternatively, growth prospects will be less promising for communities with relatively weak innovative activity, entrepreneurial environment, and human capital.

A comparison of South Carolina metropolitan areas with leading metro areas in the South provides insights into the competitive advantages and weaknesses of South Carolina’s cities with respect to developing regional systems of innovation. For example, patents per 1,000 residents (table 6) and per capita university research and development expenditures (table 7) are traditional measures of innovative activity. The leading Southern metro areas for patents were the high-technology centers Austin, Baton Rouge, and Raleigh-Durham-Chapel Hill - - all with over 2.00 patents per 1,000 residents over the period 1995-1999. The

Greenville-Spartanburg-Anderson (G-S-A) area ranked 14th in the South (out of 117) with a little over 1.0 patents per 1,000 people. The Florence and Charlotte MSA's ranked 29th and 31st respectively with patent rates of over .75 patents per 1,000 residents. The remaining South Carolina MSAs ranked 50th or below in patent rates among Southern metro areas.

A more promising competitive position for South Carolina's cities in terms of innovative activity was provided by university R&D expenditures per capita (table 7). As anticipated, the leading Southern MSA's were generally the smaller cities with major research universities (e.g., Texas A&M, University of Georgia, and University of Florida). The South Carolina cities with major universities also ranked high in terms of academic R&D expenditures. The metro areas of Columbia (16th), Charleston (20th), G-S-A (21st), and Augusta-Aiken (22nd) all ranked in the top 20% of Southern MSA's. In addition, academic R&D expenditures per capita in South Carolina cities compared favorably with those in Austin (.62), Birmingham (.75), Knoxville (.69), and Atlanta (.38).

The quality of human capital in Southern metropolitan areas was measured by the percentage of the labor force in professional occupations (table 8) and the shares of the adult population with college degrees (table 9) or high school diplomas (table 10). The Charlotte and Columbia MSA's ranked relatively high in terms of labor force quality. Charlotte ranked 13th for professional occupations and 19th for adults with college degrees. Columbia was 10th for college degrees and 11th for high school degrees. Charleston also reported a relatively high share of adults with college degrees (23rd), but Charleston ranked 40th for both professional occupations and high school graduates. Somewhat surprisingly, neither the G-S-A nor the Augusta-Aiken metro areas had high rankings for human capital. The G-S-A area ranked only 38th for professional occupations, 60th for college graduates, and 93rd for

high school graduates. Aiken-Augusta had rankings of 39th for professional occupations, 58th for college graduates, and 66th for high school graduates.

The entrepreneurial environment for Southern metro areas was represented by state venture capital investments (table 11); the share of metro establishments in professional, scientific, and technical service industries (table 12); and entrepreneurial growth companies as a share of metro businesses (table 13). South Carolina ranked 7th among the 13 Southern states in both dollar amount of venture capital investments (\$1,089 million) and investments per capita (\$271) over the 1995-2005 period. South Carolina's venture capital investments per capita were about one-third the amount available in the neighboring states of North Carolina (\$715) and Georgia (\$835). The relative lack of venture capital investments in South Carolina was both a contributor to and result of an absence of innovative activity in the state. More venture capital investments would be made if the levels of innovation and entrepreneurship increased. At the same time, individuals might more be active in innovation and product development if venture capital (and the expertise of the venture capitalist) were more readily available.

Also critical to the entrepreneurial environment are the availability of business and technical services. New business generally are too small to justify providing their own specialized business services. Thus, these firms must rely on the local business community for technical services and expertise. South Carolina's metro areas had relatively average rankings with respect to professional, scientific, and technical services establishments (NAICS 54) as a share of total establishments. The Augusta-Aiken MSA ranked 25th with a share of 9.5% and the Charleston and Charlotte MSAs ranked 40th and 48th respectively. The remaining South Carolina MSA's all ranked above 70th among the 117 Southern

metropolitan areas. As with venture capital investments, the relative absence of professional and technical services in the state's metro areas was both a contributor to and a result of a less than vibrant innovative environment.

A third indicator of the entrepreneurial environment is the presence of rapidly growing small businesses or "Gazelles." The National Commission on Entrepreneurship (2001) defined entrepreneurial growth companies as those that experienced annual employment growth rates greater than 15% or total employment growth exceeded 100% for the period 1991 to 1996. Table 13 provides the shares of entrepreneurial growth companies for select Southern and South Carolina metropolitan areas for 1991-1996. Among the state's metropolitan areas, only Charlotte and Florence had establishment shares equal to or above the national average of 4.7%. The G-S-A and Columbia's MSAs were near the national average of 4.6% and 4.5%, respectively. The relatively low share for the Charleston area (4.1%) may reflect the adjustments to major military base closings during the study period.

Summary and Conclusions

Structural changes in national and world economies place an emphasis on enhanced productivity, innovation, and entrepreneurial activity as keys to regional competitiveness. States and metropolitan areas are responding to these changes by promoting regional innovation systems that generally focus on existing or emerging industry clusters in the metro areas. The goals of this study are to identify the regional innovation systems in the South and to assess the innovative environments of South Carolina's metro areas relative to MSAs in the South.

None of South Carolina's eight metropolitan areas were classified as a Regional

Innovation System by the classification methodology used in this study. The Charleston, Charlotte, Columbia, Greenville-Spartanburg-Anderson, and Augusta-Aiken MSAs were grouped in the “Medium” cluster grouping. Florence, Sumter, and Myrtle Beach were placed in the “Below Average” grouping. The absence of a cluster of innovative activity in South Carolina should not be interpreted too negatively. Regional innovation systems were relatively uncommon and only 21 of the 117 Southern MSAs were categorized as RIS. Moreover, the five South Carolina MSAs in the “Medium” cluster grouping could be considered “emerging” clusters of innovation that could become RIS with increases in innovation and entrepreneurial activity.

The groupings provided by the cluster analysis hide some of the relative strengths and weaknesses of South Carolina’s metro areas with respect to the principal attributes associated with regional innovation systems (innovative activity, well-educated labor force, supportive entrepreneurial environment, and high local quality of life). For example, among Southern metropolitan areas, the Greenville-Spartanburg-Anderson MSA ranks high in innovative activity but medium in human capital and entrepreneurial support services (figure 1). The Columbia and Charleston MSAs, on the other hand, have less innovative activity (as reflected by patents) than G-S-A, but these metro areas rank higher in terms of human capital and entrepreneurial support. The use of innovative activity as a strategy for local economic development requires a local labor market and business services network that facilitate the growth of businesses that evolve from the innovations. Efforts to expand local innovative activity should be accompanied by programs to insure a quality labor force and adequate support services. A focus on innovation alone may result in new patents and products that must move elsewhere to develop into successful businesses.

Finally, many metropolitan areas lack the research university upon which to base an innovation focused economic development strategy. For these areas, Rosenfeld (2002) recommends creating “smart systems” based on an industry clustering approach. Suggested strategies for stimulating innovation and entrepreneurship in these developing clusters include providing investment capital for innovations and business startups, establishing incubators, facilitating entrepreneurial support and networks, and developing cluster-specific technology centers (Rosenfeld, p. 27, 28). Thus South Carolina likely will need to pursue two strategies of development: one focused on promoting emerging RIS centered on a major research university and the other addressing the development of an innovative and entrepreneurial environment around traditional industry clusters (see, for example, Shapira, 2004). A state development strategy targeted only at innovative systems will leave much of the state unserved.

End Notes

1. The South is defined as 13 states: Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, Virginia.
2. Earlier research measured innovative activity for states (Southern Growth Policy Board, 2001, 2002; DeVol et al., 2004; and Catalytix Inc., 2003), metropolitan areas (Hill, 1998; Atkinson and Gottlieb, 2001; Markusen et al., 2001; Porter 2001 a, b; Acs, 2002; and Florida, 2002); nonmetropolitan areas (Cortright et al., 2003); and regions in the European Union (Huovari et.al., 2001; Andersson and Karlsson, 2001; Todtling, 2004; and Gardiner, 2003).
3. The Southern metropolitan areas were defined according to their 1990 designations. Indicator data collected at the county level were aggregated to metropolitan level (based on the 1990 designations) and expressed in relative terms.
4. The classifications for high technology and information technology industries followed Markusen et al. (2001).
5. For this study we selected disjoint cluster analysis, an iterative partitioning method that uses the Anderberg (1973) nearest centroid sorting procedure (Aldenderfer and Blashfield, 1984). The procedure followed two principal steps. First, cluster seeds were

selected, then each observation was assigned to one of the clusters, after which the cluster seeds were recalculated and the observations were reassigned. Second, the iteration continued until the within group variation was minimized and the between group variation was maximized. The clustering was based on Euclidean distances computed from the standardized values (mean of zero and variance of one) of the observations. Standardization was performed so that the indicators with larger standard deviations would not have higher weights than indicators with lower standard deviations (Huovari et. al., 2001).

Before the cluster analysis was performed (using SAS), a correlation matrix was calculated for the indicators. If indicators were found to be highly correlated, then one indicator out of the group was selected to represent that innovation characteristic. For example, per capita academic expenditures for R&D was highly correlated with the

number of graduate science students and the number of science and engineering doctorates awarded. Academic R&D was selected to represent the three measures. Also, high technology employment and establishments were correlated with information technology employment and establishments. The employment and establishment numbers for high technology firms were selected as the proxies for agglomeration economics.

6. The Miami, FL and Washington, D.C. metropolitan areas were not included in this study because they were considered atypical Southern metropolitan areas.
7. The clusters' members were relatively stable with respect to the MSA characteristics selected as indicators of innovation and the number of clusters specified. The "Low" and "Below Average" groupings were consistent with alternative clustering specifications with the exception that some metro areas moved between the two groups. Similarly, a limited number of metro areas moved between the "High" and "Medium" clusters, indicating that the innovative capacity differences between these two groupings were not large. Finally, the "Outliers" and "College Town" groups were consistent with two exceptions: Huntsville, AL joined the "Outliers" and Auburn-Opelika, AL (Auburn University) and Starkville MS (Mississippi State University) joined the "College Towns" under alternative specifications.
8. Earnings per worker by place of work was estimated by dividing county earnings by place of work (BEA) by county employment where county employment was expressed in terms of jobs (full-and part-time). Alternatively, county earnings per worker by place of residence was estimated by dividing county net earnings by place of residence (BEA) by employed labor force (labor force less unemployed). The generally more rapid growth in earnings per resident versus earnings per worker may reflect a transition from part-time to full-time work and/or from single jobs to multiple jobs for county residents during the 1990s.
9. The number of metro and nonmetro counties in LMAs of each cluster type is as follows: Outliers (metro 32, nonmetro 31); High (metro 60, nonmetro 46); College (metro 12, nonmetro 24); Medium (metro 119, nonmetro 145); Below Average (metro 108, nonmetro 332); Low (metro 33, nonmetro 42). The metro area designation used in the LMAs is the same as that used in the cluster analysis.

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Table 1. Examples of State and Local Programs to Encourage Research and Innovation

Program	Location	Funding
Stowers Institute for Medical Research	Kansas City, MO/KS	\$2 billion Endowment
California Institute for Regenerative Medicine	State-wide	\$3 billion over 10 years
North Carolina Bio-Technology Research Campus	Kannapolis, NC	\$1 billion Endowment
The Ohio Third Frontier Project	State-wide	\$500 million
Scripps Florida	Palm Beach, FL	\$510 million
Kentucky Research Challenge Trust Fund	State-wide	\$340 million
Donald Danforth Plant Sciences Center	St. Louis, MO	\$150 million
Hudson-Alpha Institute for Biotechnology	Huntsville, AL	\$130 million
Translational Genomics Research Institute	Phoenix, AZ	\$100 million
Louisiana Optical Network Initiative	State-wide	\$40 million
Grow Wisconsin Business Incubators	State-Wide	\$30 million

Table 2. Selected Measures of Metropolitan Innovative Environment

A. Innovative Activity

Number of patents issued per 1000 population (USPTO, 1995-99)

Academic R&D expenditures per capita (NSF, 1998-2000)

Doctorates awarded in science and engineering per 1000 population (NSF, 1998-2000)

Graduate science and engineering students per 1000 population (NSF, 1998-2000)

Percentage of employment in technical professions – computer science; engineering except civil; natural, physical, and social science (BLS, 2000)

B. Labor Force Quality

Percentage of adult population (25+) that were high school graduates (Census, 2000)

Percentage of adult population (25+) that were college graduates (Census, 2000)

Percentage of population (age 16-64) that were employed (Census, 2000)

C. Entrepreneurial Environment

Percentage change in number of establishments (CBP, 1990-2000)

Percentage of establishments with fewer than 20 employees (BLS, 2000)

Number of Inc 500 companies per 100,000 population (www.inc500.com, 1990-2000)

Venture capital investments (\$) per capita (Price Waterhouse Coopers, 2000)

Percentage of employment in managerial and business professions (BLS, 2000)

Percentage of employment in SIC 73, business services (CBP, 2000)

Percentage of establishments in SIC 73, business services (CBP, 2000)

D. Localization Economics

Percentage of employment in high-technology industries (CBP, 2000)

Percentage of establishments in high technology industries (CBP, 2000)

Percentage of employment in information technology industries (CBP, 2000)

Percentage of establishments in information technology industries (CBP, 2000)

E. Competitiveness in Global Economy

Exports as a percent of gross metropolitan product, metro areas ranked in quantiles (DOC, 1999)

Table 3. Metropolitan Areas in Regional Innovation Systems Cluster Groupings

1. <u>Outliers (4)</u> Atlanta, GA CMSA Austin, TX MSA Raleigh, Durham, Chapel Hill, NC CMSA Baton Rouge, LA MSA	5. <u>Below Average (57)</u> Abilene, TX MSA Albany, GA MSA Alexandria, LA MSA Amarillo, TX MSA Ashville, NC MSA Auburn-Opelika, AL MSA Beaumont-Port Arthur, TX MSA Biloxi-Gulfport-Pascagoula, ms MSA Chattanooga, TN-GA MSA Clarksville-Hopkinsville, TN-KY MSA Columbus, GA MSA Corpus Christi, TX MSA Decatur, AL MSA Dothan, AL MSA Enid, OK MSA Evansville-Henderson, IN-KY MSA Fayetteville, NC MSA Fayetteville-Springdale-Rogers, AR MSA Florence, SC MSA Fort Smith, AR-OK MSA Fort Walton Beach, FL MSA Goldsboro, NC MSA Greenville, NC MSA Hattiesburg, MS MSA Hickory-Morganton-Lenoir, NC MSA Jackson, TN MSA Jacksonville, NC MSA Jonesboro, AR MSA Killeen-Temple, TX MSA Lafayette, LA MSA Lake Charles, LA MSA Lakeland-Winter Haven, FL MSA Lawton, OK MSA Little Rock-North Little Rock, AR MSA Long View-Marshall, TX MSA Lubbock, TX MSA Lynchburg, VA MSA Macon, GA MSA Mobile, AL MSA Monroe, LA MSA Montgomery, AL MSA Myrtle Beach, SC MSA Odessa-Midland, TX MSA Owensboro, KY MSA Panama City, FL MSA Pine Bluff, Ar MSA Rocky Mount, NC MSA San Angelo, TX MSA Savannah, GA MSA Sherman-Denison, TX MSA Shreveport-Bossier City, LA MSA Sumter, SC MSA Tuscaloosa, AL MSA Tyler, TX MSA Victoria, TX MSA Waco, TX MSA Wichita Falls, TX MSA
2. <u>High (12)</u> Dallas-Fort Worth-Arlington, TX CMSA Houston-Galveston-Brazoria, TX CMSA Huntsville, AL MSA Melbourne-Titusville-Palm Bay, FL MSA Orlando, FL MSA Pensacola, FL MSA Richmond-Petersburg, VA MSA San Antonio, TX MSA Sarasota-Bradenton, FL MSA Tampa-St. Petersburg-Clearwater, FL MSA Tulsa, OK MSA West Palm Beach-Boca Raton, FL MSA	
3. <u>College Towns (5)</u> Athens, GA MSA Bryan-College Station, TX MSA Charlottesville, VA MSA Gainesville, FL MSA Tallahassee, FL MSA	
4. <u>Medium (20)</u> Augusta-Aiken, GA-SC MSA Birmingham, AL MSA Charleston-North Charleston, SC MSA Charlotte-Gastonia-Rock Hill, NC-SC MSA Cincinnati-Hamilton, OH-KY-IN MSA Columbia, SC MSA Greensboro--Winston-Salem--High Point, NC MSA Greenville-Spartanburg-Anderson, SC MSA Jackson, MS MSA Jacksonville, FL MSA Knoxville, TN MSA Lexington, KY MSA Louisville, KY-IN MSA Memphis, TN-AR-MS MSA Nashville, TN MSA New Orleans, LA MSA Norfolk-Virginia Beach-Newport News, VA-NC MSA Oklahoma City, OK MSA Roanoke, VA MSA Wilmington, NC MSA	

Table 3. Metropolitan Areas in Regional Innovation Systems Cluster Groupings (Cont.)

6. Low (18)
Anniston, AL MSA
Brownsville-Harlingen-San Benito, TX MSA
Danville, VA MSA
Daytona Beach, FL MSA
El Paso, TX MSA
Florence, AL MSA
Fort Myers-Cape Coral, FL MSA
Fort Pierce-Port St. Lucie, FL MSA
Gadsden, AL MSA
Houma, LA MSA
Huntington-Ashland, WY-KY-OH MSA
Johnson City-Kingsport-Bristol, TN-VA MSA
Laredo, TX MSA
McAllen-Edinburg-Mission, TX MSA
Naples, FL MSA
Ocala, FL MSA
Punta Gorda, FL MSA
Texarkana, TX-Texarkana, AR MSA
-

Table 4. Mean Values for Indicators of Innovation by Cluster Grouping

Indicators	Outliers	High	College Towns	Medium	Below Average	Low
1. <u>Innovative Activity</u>						
Patents issued (per 1000 population)	.58	.20	.24	.14	.08	.07
Academic R&D (\$ per capita)	482.34	47.59	1357.06	86.79	51.52	2.57
Employment in Tech. Prof. (%)	7.25	4.02	3.29	2.86	1.65	1.03
2. <u>Labor Force Quality</u>						
High School Graduates (%)	84.03	82.09	83.88	81.09	78.48	71.96
College Graduates (%)	33.13	25.38	37.32	24.47	19.23	16.10
Working Population (%)	69.28	62.42	64.82	65.66	63.29	54.40
3. <u>Entrepreneurial Environment</u>						
Change in Establishments (%)	39.65	22.41	19.90	22.54	13.95	33.19
Establishments < 20 emp. (%)	84.33	85.86	86.00	84.06	85.08	87.71
Inc. 500 Companies (%)	8.25	0.25	0.00	1.45	0.05	0.00
Venture Capital Per Capital (\$)	386.71	281.53	122.62	44.13	7.57	0.00
Business Services Emp. (%)	9.67	11.16	5.92	7.72	5.51	5.52
Business Services Estab. (%)	7.81	7.26	5.83	5.88	4.44	4.63
Emp. In Mng. And Bus. Prof. (%)	12.67	7.33	7.48	7.06	5.49	4.39
4. <u>Agglomeration Economics</u>						
High Tech Employment (%)	11.40	7.46	4.53	6.60	5.10	3.25
High Tech Establishments (%)	9.55	8.73	9.14	6.75	5.56	4.76
5. <u>Competitiveness</u>						
Export Rank (1-4)	3.75	3.17	1.20	3.40	1.49	1.89

Table 5. Changes in Aggregate Economic Activity by Cluster Groupings, 1990-2000

	Mean Change in Employment (%)	Mean Change in Population (%)	Mean Change in Earnings Per Worker by Place of Work (%)	Mean Change in Earnings Per Employed Resident by Place of Residence (%)
A. Metro Counties				
Outliers (32) ^a	62.26	44.27	51.89	96.20
High (58)	42.20	28.25	40.25	69.04
College Towns (13)	42.61	31.74	39.10	62.29
Medium (113)	34.51	20.27	42.34	54.02
Below Average (106)	26.88	14.69	37.10	47.60
Low (33)	24.27	17.87	31.13	40.62
B. Nonmetro Counties				
Outliers (31)	32.74	23.00	37.16	60.97
High (40)	31.27	22.01	31.88	53.04
College Towns (24)	25.29	22.22	36.47	49.98
Medium (136)	21.33	12.25	39.87	41.86
Below Average (315)	15.89	7.06	31.90	30.71
Low (42)	19.55	12.83	34.92	37.41
Rural LMAs (349)	17.88	10.39	35.63	35.79

^a Number of metro or nonmetro counties in the cluster grouping.

Table 6. Patents Per 1000 People by Southern Metropolitan Area, 1995-1999

Leading Southern Metropolitan Areas

1. Austin-San Marcos	4.28
2. Baton Rouge	3.71
3. Raleigh-Durham-Chapel Hill	2.66
4. Gainesville, FL	1.96
5. West Palm Beach-Boca Raton	1.75
6. Houston	1.52
7. Dallas-Fort Worth-Arlington	1.49
8. Melbourne-Titusville-Palm Bay	1.45

South Carolina Metropolitan Areas

14. Greenville-Spartanburg-Anderson	1.16
29. Florence	.79
31. Charlotte-Gastonia-Rock Hill	.75
50. Charleston	.56
51. Columbia	.54
64. Augusta-Aiken	.39
82. Myrtle Beach	.31
104. Sumter	.17

Table 7. Total R&D Expenditures at Universities and Colleges, 1998-2000*Leading Southern Metropolitan Areas*

<u>Area</u>	<u>Total R&D 1998-2000</u>	<u>R&D Expenditures Per Capita</u>
1. Bryan-College Station, TX	1,193,191,000	\$7.81
2. Athens, GA	713,914,000	4.63
3. Gainesville, FL	893,001,000	4.09
4. Baton Rouge, LA	703,565,000	3.62
5. Hattiesburg, MS	388,843,000	3.46
6. Charlottesville, VA	410,689,000	2.56
7. Auburn-Opelika, AL	260,924,000	2.26
8. Raleigh-Durham-Chapel Hill, NC	2,550,055,000	2.12

South Carolina Metropolitan Areas

<u>Area</u>	<u>Total R&D 1998-2000</u>	<u>R&D Expenditures Per Capita</u>
16. Columbia	305,927,000	\$.57
20. Charleston	179,002,000	.33
21. Greenville-Spartanburg-Anderson	306,074,000	.32
22. Augusta-Aiken	133,100,000	.28
54. Charlotte-Gastonia-Rock Hill	36,745,000	.02
68. Myrtle Beach	1,638,000	.01
NR Florence	0	0
NR Sumter	0	0

Source: National Science Foundation

Table 8. Percentage of Metropolitan Labor Force in Professional Occupations, 2000*

Leading Southern Metropolitan Areas

1. Huntsville	10.1%
2. Raleigh-Durham-Chapel Hill	8.5
3. Melbourne-Titusville-Palm Bay	8.1
4. Austin-San Marcos	7.7
5. Dallas-Fort Worth-Arlington	6.3
6. Houston	5.9
7. Tallahassee	5.1
8. Atlanta	4.7

South Carolina Metropolitan Areas

13. Charlotte-Gastonia-Rock Hill	3.9%
31. Columbia	3.2
38. Greenville-Spartanburg-Anderson	2.9
39. Augusta-Aiken	2.9
40. Charleston	2.8
69. Sumter	1.8
81. Myrtle Beach	1.6
87. Florence	1.5

* Professional occupations include Computer and Mathematical Operations (15-0000); Life, Physical and Social Science Occupations (19-0000); and Architecture and Engineering Occupations (17-0000)

Table 9. Share of Adult Population with College Degrees, 2000

Leading Southern Metropolitan Areas

1. Charlottesville	40.1%
2. Raleigh-Durham-Chapel Hill	38.9
3. Gainesville, FL	38.7
4. Bryan-College Station	37.0
5. Austin-San Marcos	36.7
6. Tallahassee	36.7
7. Athens, GA	34.1
8. Atlanta	32.0

South Carolina Metropolitan Areas

10. Columbia	29.2%
19. Charlotte-Gastonia-Rock Hill	26.5
23. Charleston	25.0
58. Augusta-Aiken	20.9
60. Greenville-Spartanburg-Anderson	20.7
74. Florence	18.7
75. Myrtle Beach	18.7
99. Sumter	15.8

Source: U.S. Census, 2000

Table 10. Share of Adult Population with High School Diplomas

Leading Southern Metropolitan Areas

1. Gainesville, FL	88.1%
2. Fort Walton Beach	88.0
3. Melbourne-Titusville-Palm Bay	86.3
4. Tallahassee	85.9
5. Raleigh-Durham-Chapel Hill	85.4
6. Lawton, OK	85.2
7. Fayetteville, NC	85.0
8. Austin-San Marcos	84.8

South Carolina Metropolitan Areas

11. Columbia	84.3%
40. Charleston	81.3
44. Myrtle Beach	81.1
52. Charlotte-Gastonia-Rock Hill	80.5
66. Augusta-Aiken	78.9
93. Greenville-Spartanburg-Anderson	75.4
99. Sumter	74.3
108. Florence	73.1

Source: U.S. Census, 2000.

Table 11. Venture Capital Investments in the South, by State, 1995-2005

State	Deals	Investments (millions)	Investments Per Capita
Texas	2154	\$18,403	\$ 883
Virginia	1098	8,340	1,178
Florida	833	8,037	503
Georgia	1026	6,834	835
North Carolina	869	5,755	715
Tennessee	273	1,921	338
South Carolina	87	1,089	271
Alabama	130	817	184
Louisiana	83	631	141
Kentucky	93	500	124
Oklahoma	67	446	129
Mississippi	28	338	119
Arkansas	26	68	25

Source: PriceWaterhouseCooper Money Tree

Table 12. Share of Establishments in Professional, Scientific, and Technical Services Industries (NAICS 54), 1997

Leading Southern Metropolitan Areas

1. Miami – Fort Lauderdale	27.7%
2. Richmond – Petersburg	14.1
3. Tallahassee	12.7
4. Austin-San Marcos	12.7
5. Atlanta	12.2
6. West Palm Beach – Boca Raton	12.1
7. Huntington-Ashland	11.4
8. Raleigh-Durham-Chapel Hill	11.4

South Carolina Metropolitan Areas

25. Augusta-Aiken	9.5%
40. Charleston	8.4
48. Charlotte-Gastonia-Rock Hill	8.0
73. Greenville-Spartanburg-Anderson	7.1
76. Columbia	6.8
90. Sumter	6.2
102. Myrtle Beach	5.8
109. Florence	5.4

* Source: 1997 Economic Census

** NAICS 54 activities include legal advice and representation; accounting, bookkeeping, and payroll services; architectural, engineering, and specialized design services; computer services; consulting services; research services; advertising services; photographic services; translation and interpretation services; veterinary services; and other professional, scientific, and technical services.

Table 13. Entrepreneurial Growth Companies as a Share of Business in Labor Market Areas, 1991-1996

Entrepreneurial Growth Companies

- Annual employment growth rate $\geq 15\%$
- Employment growth $\geq 100\%$ for 1991-96

Southern Metropolitan Areas

<u>Labor Market Area</u>	<u>Companies</u>	<u>High Growth</u>	<u>Share</u>
Austin-San Marcos	20,915	1,514	7.2%
Atlanta	69,279	4,479	6.5
Nashville	24,458	1,465	6.0
Pensacola	10,863	643	5.9
Raleigh	25,768	1,507	5.8
Little Rock	13,036	757	5.8
Charlotte	28,383	1,544	5.4
United States Average			4.7
Florence	12,091	567	4.7
Green.-Spart.-Ander.	22,771	1,049	4.6
Columbia	13,577	607	4.5
Augusta-Aiken	9,106	393	4.3
Charleston	12,350	507	4.1
Sumter	3,185	118	3.7

Source: National Commission on Entrepreneurship, 2001.

Rank Among
Southern
Metro Areas

Top 25% (1-29)	G-S-A Florence	Columbia Charlotte Charleston	Augusta-Aiken	?
(30-59)	Charlotte Charleston Columbia	Augusta-Aiken	Charleston Charlotte	?
(60-89)	Augusta-Aiken Myrtle Beach	G-S-A Florence Myrtle Beach	G-S-A Columbia	?
Bottom 25% (90-117)	Sumter	Sumter	Sumter Myrtle Beach Florence	?
	Innovative Activity (Patents)	Human Capital (College Graduates)	Entrepreneurial Support (Professional Services)	Local Quality of Life

**Figure 1. Ranking of South Carolina Metropolitan Areas
Across Regional Innovation System Indicators**

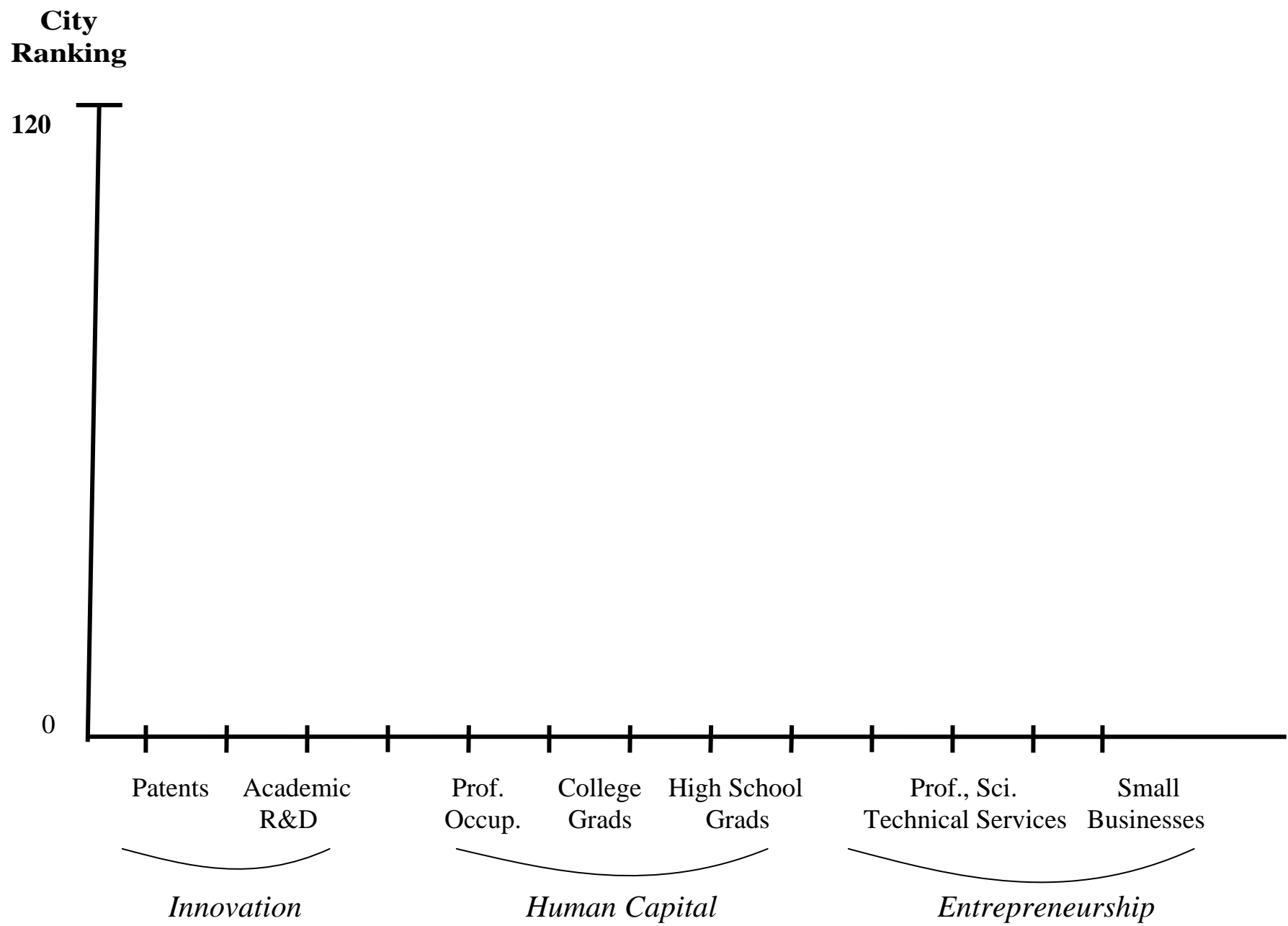


Figure 1.