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Building a Knowledge Economy Index for Southern Metropolitan Areas

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BUILDING A KNOWLEDGE ECONOMY INDEX
FOR SOUTHERN METROPOLITAN AREAS

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ABSTRACT

The purpose of this thesis is to determine if the methodology used to build the South Carolina Research Authority Knowledge Economy Index (KEI) for states can be replicated and applied to Southern Metropolitan Statistical Areas (MSAs). Data to imitate the KEI measures for workforce education and fast growth firms were available at the MSA-level; however, academic R&D was used as a proxy for industrial R&D in this index because data was not available for MSAs. An index for Southern MSAs was built based on the coefficients from the OLS results. Workforce education was the most important factor for increasing mean per capita income. The fast growth firms variable was not significant in the regression. Academic R&D had a negative coefficient, the opposite sign of industrial R&D in the KEI. The residual analysis and the high rankings of university cities revealed this type of MSA to be critical to the index. Further analysis was performed on the education variable to determine the source of the high coefficient in the OLS results. Finally, this index was compared to other relevant indices. The thesis offers research-based suggestions for improving MSA-based Knowledge Economy indices. Other research is also recommended that focuses on university cities and the relationship between MSAs and the states in which they are located.

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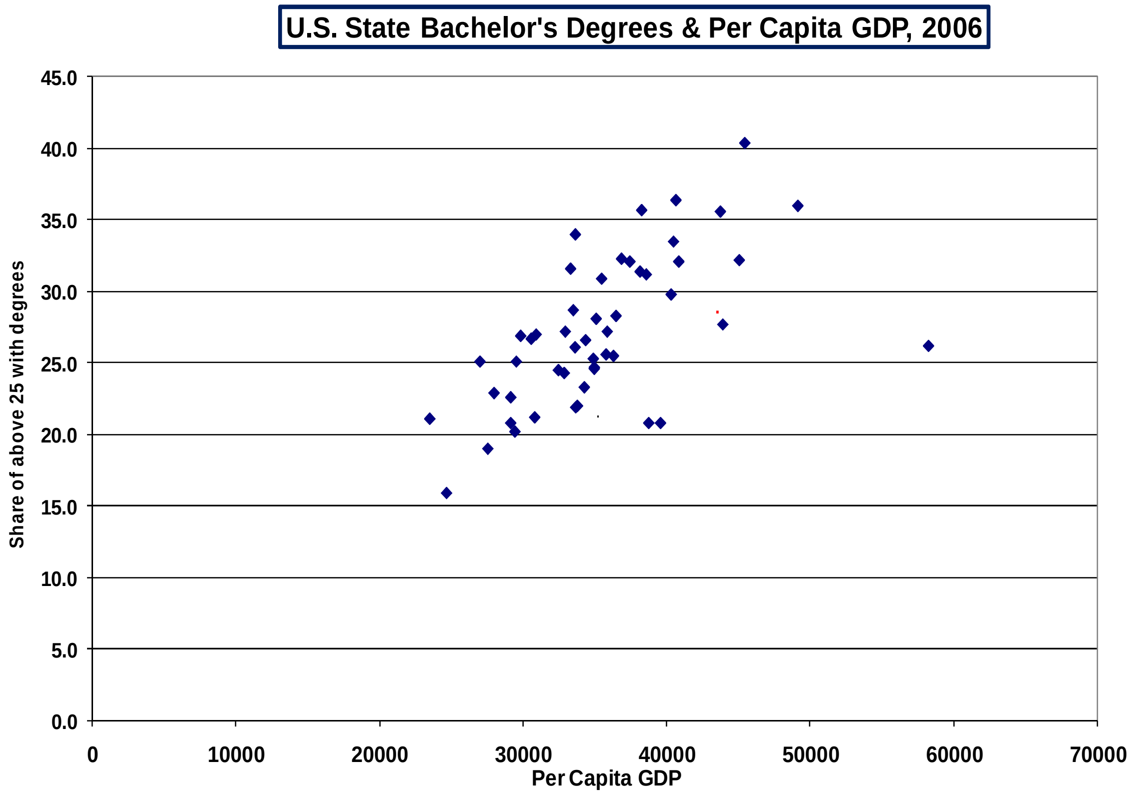
Chapter 1

INTRODUCTION AND BACKGROUND

Introduction

The transition to a Knowledge Economy is an important topic in research for a wide range of sciences. The effects of this evolution in the economy are comparable to the changes in society caused by the introduction of steam power at the beginning of the Industrial Revolution and the widespread usage of the assembly line in the 1920s. Every aspect of life has been affected by the accelerating rate of technological change, but it is the recognition of knowledge as not just a tool, but as a primary product, that has revolutionized the economy.

Economists are interested in the Knowledge Economy for a number of reasons, one of which is the effects on individual welfare. Figure 1, from a presentation by Bruce Yandle (2008), plots U.S. state per capita income to the share of state population, 25 years and older, with a bachelor's degree. This mapping illustrates the strength of the relationship between education and per capita GDP.



Policymakers are interested in improving per capita GDP, one measure of individual welfare. According to the figure, there are two ways to move right towards increased GDP. One, legislators can work towards increasing education on the y-axis, which will shift their state to the right. Two, policymakers could attempt to move to the right along the x-axis by supporting initiatives that reduce transaction costs thereby improving the use of knowledge in society. Regardless, the correlation between knowledge and welfare reveals a significant and positive relationship. The strength of the relationship enforces the dominant role of education in the Knowledge Economy.

The role of knowledge in the economy has long been recognized. John Stuart Mill proposes human capital as a factor that contributes to the growth of the economy in his (1848) The Principles of Political Economy.

> The production of wealth; the extraction of the instruments of human subsistence and enjoyment from the materials of the globe, is evidently not an arbitrary thing. It has its necessary conditions. Of these, some are physical, depending on the properties of matter, and on *the amount of knowledge of those properties possessed at the particular place and time*.[1] … in which must lie the explanation of the diversities of riches and poverty in the present and past, and the ground of whatever increase in wealth is reserved for the future.[2]

In this century, Gary Becker has played a major part in developing the theory of human capital and its effects on society (*The Concise Encyclopedia of Economics*[3]). Starting in the 1960s, Becker was one of the first to examine education as an investment, which today is its standard treatment. The importance of Becker's research has become more pronounced since the technology boom catalyzed the emergence of the Knowledge Economy.

The transition to the Knowledge Economy has raised a great deal of interest in the role of all factors of the Knowledge Economy in growth and development (Berman et al., 1998; Goldman & Sachs, 2000; McGuckin & van Ark, 2001). The rising importance of knowledge has changed the entire structure of the economy. Achieving stability and lowering costs of production are no longer the goals for economic growth. Instead,

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[1] Italics are my own.

[2] John Stuart Mill, *The Collected Works of John Stuart Mill, Volume II - The Principles of Political Economy with Some of Their Applications to Social Philosophy (Books I-II),* ed. John M. Robson, introduction by V.W. Bladen (Toronto: University of Toronto Press, London: Routledge and Kegan Paul, 1965). Chapter: *Preliminary Remarks*. Accessed from http://oll.libertyfund.org/title/102/9684 on 2008-11-05

[3] http://www.econlib.org/library/Enc/HumanCapital.html

dynamism and the ability to innovate have become determinants of the health of firms. Governments must now focus on attracting high quality employment, which means drawing human capital rather than physical capital that is associated with mass quantities of jobs. Innovation and knowledge are the focal point for economists, firms and public policy. For economists, this shift in the economy means that finding and applying new ways of measuring and determining growth are necessary.

The South Carolina Research Authority Knowledge Economy Index (KEI) was designed to compare key indicators of the knowledge economy in South Carolina to the other states (Waktins, 2008). By testing a wide variety of potential contributors to the Knowledge Economy, Watkins was able to build an index that ranked the 50 states according to factors that proved to be important in determining the welfare of the population. The focus of this thesis is to determine if the methodology used by Watkins to build the KEI for states can also be applied to Metropolitan Statistical Areas (MSAs). MSAs are geographical regions defined by the Census Bureau that are associated with an urban area.

South Carolina Research Authority Knowledge Economy Index

The purpose of Watkins' index was to measure South Carolina's performance in the Knowledge Economy in comparison with the other states of the U.S. The KEI was designed to be replicated each year to determine and track the progress that South Carolina makes over time. Therefore, the methodology was formulated in order to minimize the costs of future duplication and maximize its policy implications for South Carolina.

Watkins built several regression models using indicators from The State New Economy Index (Atkinson, 2007). The independent variables tested were: fast growth firms, gazelle jobs, high tech jobs, industry research and development, job churning, professional and technical jobs, patents, scientists and engineers, venture capital, and workforce education. The performance of income per capita and GDP per capita were compared as dependent variables. In addition, two control variables were tested, median age and mean temperature.

Per capita income was selected as the variable to compare the effects of the Knowledge Economy across states. In the literature and in policy decisions, income per capita is generally the factor that is most influential. Higher per capita incomes in states were also generally associated with larger shares of knowledge economy sectors.

Watkins argued that the three primary characteristics of a healthy and growing Knowledge Economy are knowledge, innovation, and entrepreneurship. Three preliminary models were tested to determine which proxies of these factors would have the most impact on income per capita. The first conceptual model was based on R&D and entrepreneurship and the second model was focused on education. The final preliminary model combined the most important factors from the previous two models.

The first model was run with industrial R&D, fast growth firms, venture capital, patents and the two control variables, median age and mean temperature. Industrial R&D, fast growth firms, venture capital, and median age were all significant at the 5% level. Patents and mean temperature were not statistically significant. The second model was composed of workforce education, professional and technical jobs, scientists and engineers, and the two control variables. The only variables significant in this model were workforce education and median age. Watkins then combined the significant variables into a third model. In the new model, venture capital was no longer significant, but industry R&D, workforce education, and fast growth firms were significant at the 5% level. Mean temperature was still not statistically significant.

The final model that Watkins used to determine the coefficients to be used in the index was composed of industry R&D, workforce education, and fast growth firms. Watkins used as median age as the only control variable, since mean temperature never showed any significance. Table 1 shows the results of Watkins' final statistical model.

Table 1: Regression Results for Watkins' Final Model

Regressor	Coefficient	T-statistic
Workforce Education	386.935	5.91**
Fast Growth Firms	380.682	2.20**
Industrial R&D	231.244	1.26
Median Age	355.318	2.20**
Constant	-4944.500	-0.76
Summary Statistics		
Observations	42	
F-statistic	23.83	
R-squared	0.7204	

***1% significance level
**5% significance level
*10% significance level

Workforce Education divided by 100
Fast Growth Firms divided by 10000
Industrial R&D divided by 100

Though industry R&D was no longer significant in the final model, Watkins chose to keep the parameter in the final index. He proposed that workforce education was such a strong factor that it negated the effects of industrial R&D. Theoretically, innovation, as proxied by industrial R&D, is an essential aspect of the Knowledge Economy; however, the measurement used by the KEI was not an effective measure.

Using the coefficients from the final analysis, the index was built using workforce education, fast growth firms, and industry R&D. The raw data for each state was multiplied by the coefficient to obtain a score for each state. Based on this score, the states were ranked highest to lowest. South Carolina received a rank of 39 based on this methodology, which is congruous with results from other indices. The full index is included in Appendix 1. Overall, Watkins was successful in creating an index that is easily replicable over time. The evaluation of the KEI in comparison to other indices reveals that it is an effective method of comparing the Knowledge Economy across states.

Background

Inquiries into the nature of economic growth are as old as the discipline of economics and as current as today's newspaper. Adam Smith's 1776 treatise that marks the foundation of modern economic science, titled *An Inquiry into the Nature and Causes of the Wealth of Nations,* addresses the issue of economic growth. Economic progress has always been a fundamental concern of people and nations, well before the development of economic theory as a science. Inquiries into economic growth have focused on a number of explanations, but education—knowledge—are chief among those explanations in modern times. This section begins with a brief summary of ideas about the relationship of knowledge to economic growth that have been expressed by economists. Then, measures currently used to analyze the knowledge economy are explored, with a focus on the characteristics described in the KEI index: education, innovation, and entrepreneurship. This discussion leads to an examination of the knowledge economy itself and attempts to measure it.

Knowledge

Alfred Marshall proclaimed that "the most valuable of all capital is that invested in human beings" (Marshall, 1890; page 529). But it was not until Gary Becker that economists first began to directly address the role of human capital, or knowledge, in the economy. In the article "Human Capital," Becker (1964) christens the period from the late 1800s to present the Age of Human Capital. Becker defines human capital to be composed of the knowledge, skills, and health of the population. In regards to the role of human capital in the economy, Becker asserts that "human capital is absolutely essential to growth in the modern world" (Becker, 1964: 3).

Becker (1975) provided evidence for the importance of human capital by empirically testing the relationship between human capital and wage earnings. As anticipated, an increased stock of human capital raises the potential lifetime earnings of an individual. Becker (1975) does not restrict knowledge to formal education, but also considers on the job training and other education opportunities. Throughout his career, Gary Becker has continued to study the role of knowledge in the economy (Becker, 1985; 1986; with Murphy, 2007).

Measurements of the Knowledge Economy

Human capital is a vital aspect of the Knowledge Economy for several reasons. First, it increases real wages. As Becker (1964) first modeled, human capital is a necessary factor for growth and development. Education and training increases earnings, leads to improved health, and even adds to an individual's good habits. Increased human capital is also important in a person's ability to use technology, a vital part of the Knowledge Economy. Becker also argues that education influences families through the transfer of knowledge and values (Becker, 1964).

Abel and Gabe (2008) discuss human capital in relation to metropolitan areas in "Human Capital and Economic Activity in Urban America." As they explain, human capital increases wages in regional areas in two ways. First, human capital increases productivity, which increases wages. Second, higher concentrations of human capital create knowledge spillovers that further increase productivity. Abel and Gabe further assert that human capital increases the innovative production of a metropolitan area. This paper also proposes a link between knowledge and innovation.

Other research on human capital asserts that it attracts high-skilled firms with higher real wages. Berry and Glaeser (2005) model the decision of firms to locate to areas with elevated workforce education in "The divergence of human capital across cities." This paper proposes that it is high-skilled entrepreneurs who tend to start firms that require high-skilled labor. The model further assumes that entrepreneurs often start their businesses in their home towns and that firms must stay in the same location for the first few years of start-up. Based on these assertions, it is obvious how workforce education is correlated not only with increased per capita income, but also with highly innovative and entrepreneurial environments. Berry's and Glaeser's (2005) work provides further evidence of the relationships between knowledge, innovation, and entrepreneurship that is the foundation of this index.

Fast growth firms, also called gazelle firms, also play an important role in the Knowledge Economy. The proliferation of studies examining the fastest growing firms, such as the Inc. 500 and the Deloitte Technology Fast 500, attest to the importance of these companies in the new economy. Henrekson and Johansson (2008) examined fast growth firms in their paper "Gazelles as Job Creators- A Survey and Interpretation of the Evidence." They test several hypotheses about gazelles that have been proposed in the literature, particularly those that relate to employment. The results are overwhelming evidence that fast growth firms are responsible for a disproportionate number of the new jobs created.

Paul Schreyer (2000) finds the same results for fast growth firms in his paper "High-Growth Firms and Employment." Schreyer discusses two primary findings. First, fast growth firms account for a disproportionate number of jobs gained. Second, small firms account for more job growth than large firms, a result that is often reported with gazelle companies.

In "High-Impact Firms: Gazelles Revisited," Acs et al. (2008) find that fast growth firms are responsible for the majority of overall employment growth. This strong statement is supported by panel data of firms that demonstrate two primary results. First, gazelles, or high-impact firms, are much older than news articles tend to report, on average 25 years old. Second, these companies are responsible for well over a third of the jobs created. Acs et al.'s results support the role of fast growth firms in the Knowledge Economy.

Zoltan Acs (2002) studied the interaction between entrepreneurship, innovation, and economic growth in his book *Innovation and the Growth of Cities*. Acs finds several important relationships, such as the spatial limitation of knowledge spillovers and the rapport between innovation and firm size. Another result is the association of university R&D with high-tech employment. This becomes a key Knowledge Economy factor studied in this paper. Though Acs reports that the degree to which an MSA benefits from academic research differs according to its size, the impact of research and development is found to be positive.

Adam Jaffe (1989) is responsible for much of the initial research on academic research and development. In his paper "Real Effects of Academic Research," Jaffe empirically tests the creation of knowledge spillovers from academic research and development to corporate patents and industrial research. He finds two main results. First, that academic R&D tends to induce industrial R&D, which is an important result for the measurement of innovation in metropolitan areas since industrial R&D data are not currently available. Jaffe also finds that there is a significant positive effect of academic research on corporate patents, particularly in the drugs and electronics industries.

In a later paper "Universities and the Startup of New Companies: Can We Generalize from Route 128 and Silicon Valley," Bania et al. (1993) further studies the implications of academic research and development. In his research, Bania discusses the ways in which research universities impact their local firms. First, local companies may hire new graduates, thus connecting the skilled workforce to skilled employment. Local firms may also benefit from consulting faculty and utilizing universities for the training of their employees. Local firms also have access to university resources, such as labs, libraries and specialized equipment. Bania finds similar results to Jaffe's (1989) paper, that academic R&D has important effects on certain industries, specifically electronics, but not necessarily in other sectors.

Anselin et al. (1997) confirm Jaffe's results, but with wider implications, in "Local Geographic Spillovers between University Research and High Technology Innovations." Anselin finds that academic R&D affects MSAs in two ways. First, academic research creates knowledge spillovers in the local community. Second, by increasing private (industrial) R&D, university R&D further increases the knowledge spillovers and, thus, the benefits from increased innovation and research. This research further supports the use of academic R&D as a proxy for industrial R&D in the index developed in this thesis.

Riddel and Schwer (2003) study the effects of industry research and development in relation to innovation in "Regional Innovative Capacity with Endogenous Employment: Empirical Evidence from the U.S." This paper examines how the stock of knowledge, industrial R&D, and high-tech employees affect the rate of change in innovation. Riddel and Schwer find that these factors, along with the stock of human capital and patenting activity, can explain the innovative capacity of regions. This study adds to the evidence for the relationship between knowledge and innovation.

Reports and Indices

There are several notable efforts at the international level to quantify and examine the Knowledge Economy. The World Bank has an entire section of its organization devoted to understanding the effects of knowledge on developing countries, called Knowledge for Development (K4D[4]). The research performed by this branch of the World Bank provides an online tool for comparing Knowledge Economy indicators across countries. The Knowledge for Development Program allows users to create scorecards of 140 countries based on 83 different measures of the Knowledge Economy. This program identifies four categories of indicators, similar to Watkins' three, but with an added aspect necessary for comprehension of the Knowledge Economy on an international level: institutional regime (*Knowledge for Development*).

In Europe, an annual workshop called the KEI examines indicators of the Knowledge Economy.[5] The work done for this workshop attempts to improve the data used to measure the Knowledge Economy and identify the factors that can be the most useful for policy makers over the medium-term. The project covers 30 European countries and 6 non-European (including the U.S.) countries and researches a wide variety of Knowledge Economy components. Some of the inquiries for the workshop include research which pertains to composite indicators and statistical methods (KEI Notes, 2005).

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[4] www.worldbank.org/wbi

[5] Workshop last met November 8th-9th, 2007

The Global Entrepreneurship Monitor (GEM) is an annual report that analyzes indicators specifically relevant to entrepreneurship across countries.[6] As is discussed in the 2007 Executive Report, small firms are advantageous to the Knowledge Economy for several reasons. First, they generate more innovation than established firms, which is an important contributor to the Knowledge Economy. In addition, small firms often generate knowledge as a product to the economy. They also fill market niches and increase competition, both of which contribute to economic dynamism, which is an important factor in the Knowledge Economy (Bosma et al., 2007).

On a national level, Robert Atkinson has produced a wide range of indices and reports relevant to the Knowledge Economy (Atkinson, 1998) in the U.S. One of the first efforts to create an index of the Knowledge Economy was the New Economy Index, published by the Progressive Policy Institute in 1998. This paper discusses the transformation that the economy was undergoing during the 1980s and 1990s and made policy suggestions to support the new economy. It discusses the changing importance of industry sectors and the movement of high paying employment. In addition, the New Economy Index discusses the role of the IT revolution in increasing competition, globalization and economic dynamism.

After studying the knowledge economy from a national level, Atkinson reports the effects of the new economy on MSAs in the Metropolitan New Economy Index (Atkinson, 2001). This study examines 16 economic indicators in relation to the 50 largest metropolitan statistical areas (MSAs). The Metropolitan New Economy Index

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[6] http://www.biceps.org/files/GEM%2007%20EN%20print.pdf

uses variables such as workforce education and gazelle firms, but substitutes academic R&D for industrial R&D. Though industrial R&D is generally preferred because it more directly affects the Knowledge economy, the data are not available at the MSA-level.

Atkinson then developed the State New Economy Index with the Kauffman Foundation (Atkinson, 2007). Watkins used the 2007 version of this index as a primary resource in building the KEI. This report is based on 26 indicators of the Knowledge Economy, including workforce education, fast growth firms, and industrial research and development. As in the KEI, the 2007 State New Economy Index ranks South Carolina 39^{th}.

The Milken Institute is a think tank that publishes a variety of economic papers, including an annual report called Best Performing Cities (DeVol et al., 2008). This index examines a more specific aspect of the Knowledge Economy, namely the job and wage growth associated with a changing economy. In addition, this report observes high-tech GDP and employment growth to determine which U.S. MSAs are adapting to the dynamic nature of the Knowledge Economy most efficiently. South Carolina has two MSAs that rank in the top 20 of this index, Charleston and Myrtle Beach.

Another attempt at comparing MSAs is seen in the Regional Economic Dashboard (Eberts et al., 2006). This index examines 40 variables for 118 metropolitan areas in an innovative analysis. Eberts et al. use factor analysis to statistically group the 40 indicators into eight categories. These groupings were then used to rank each MSA and compiled to create an index. In this report, the variables studied were clustered into workforce skill, urban assimilation, racial inclusion, income equality, locational amenities, economic dynamism, metropolitan structure, and manufacturing "legacy."

The indices found in the reports discussed above (with exception of the workshops on Knowledge Economy Indicators), use arbitrary weights or box score methodology to build their indices. Along these lines, Barkley and Henry (2006) examine the raw data in order to rank MSAs in their paper "Innovative Metropolitan Areas in the South: How Competitive are South Carolina's Cities?" This report uses 20 indicators to rank Southern MSAs, including innovation, entrepreneurial environment, human capital, and global competitiveness measures. They then use cluster analysis and identify six groupings of MSAs with distinctive Knowledge Economy attributes, of which South Carolina cities ranked in the medium and below average categories. This thesis uses the 114 Southern MSAs from Barkley and Henry's paper as the sample set.

Barkley and Henry (2008) also created an index specifically designed to compare the Greenville MSA to other relevant Southern cities. The Greater Greenville Regional Economic Scorecard identifies Greenville's "peer" cities and "target" cities as benchmarks for analysis. The factors examined are similar to those from the paper "Innovative Metropolitan Areas in the South": knowledge jobs, labor quality, global competitiveness, economic dynamism, entrepreneurial environment, and innovative capacity.

The Greater Greenville Regional Economic Scorecard uses an innovative method for comparing MSAs. To rank each MSA by labor quality, for example, the percentage of the population with high school degrees in Greenville is weighted by the national average. Then, MSAs with higher than the national average will have an index score of over 100, while those below the national average score less than 100. This methodology normalizes the data to facilitate comparisons between regions and evaluates the effects of various factors on the Knowledge Economy using descriptive statistics.

This thesis adds to the current literature in two manners. First, by applying the statistical methods implemented on states for the KEI to MSAs, this thesis examines the relationship between geographic components. Second, this thesis further analyzes the role of workforce education, fast growth firms, and academic R&D in the Knowledge Economy. The next chapter will discuss the examination of the data, the development of the statistical models, and the results of this effort to replicate the KEI for Southern MSAs.

Organization of the Thesis

The purpose of this paper is to replicate the methodology used to develop the KEI for states and apply it to 114 MSAs in the Southern states. The paper is organized as follows. The second chapter presents the methodology used to build an index for a sample of U.S. MSAs and then presents the statistical findings. The results are analyzed in comparison to the KEI and other relevant indices. The third and final chapter discusses a future index and proposes additional aspects of the Knowledge Economy that would be relevant to examine in relation to MSAs. Statistical models for future research are proposed.

Chapter 2

BUILDING A STATISTICAL MSA KNOWLEDGE ECONOMY INDEX

This chapter describes the process undertaken to build an index measuring the Knowledge Economy for a sample of 114 Southern Metropolitan Statistical Areas (MSAs) and a subset of the sample that includes MSAs from South Carolina and neighboring states. South Carolina MSAs are also analyzed independently. A listing of the MSAs can be found in Appendix 2. The primary purpose of this study is to determine if the methodology used to develop the South Carolina Research Authority Knowledge Economy Index (KEI) for states can be used effectively to build an index for MSAs.

First, a data set is defined that parallels the data used in the KEI. Proxies are developed for the parameters that cannot be replicated for MSAs. Then, several regression models are developed and estimated using per capita income as a dependent variable and the KEI and proxy variables as the independent measures. An index is estimated for MSAs using the regression results. Further analysis of the education variable is presented and, finally, the index rankings are compared to other useful indices.

Construction of Variables

After testing to find the most relevant variables, the end product KEI was composed of three variables: education level of the workforce, proliferation of fast growth firms, and the extent of industrial research and development. The education variable was the weighted sum of doctoral, masters, bachelors, and associates degree divided by the total population over the age of 25. The KEI developed the fast growth firms variable by calculating the ratio of companies in the Inc. 500 and Deloitte

Technology Fast 500 lists versus the total number of firms in the state. Industrial research and development figures were weighted by total personal income to develop the industrial R&D variable. The education and fast growth firms variables were both available in identical forms for MSAs. Industrial R&D data was not available for MSAs, so academic R&D was used as a substitute.

The dependent variable in the KEI was income per capita. This measure was also available for Southern MSAs through the 2006 American Community Survey. When discussing the knowledge economy, income per capita is generally the dependent variable that is concerned. Policy makers are interested in the effect that the knowledge economy has on individual welfare and mean income per capita is widely accepted as the best indicator.

The educational attainment of the workforce population (age 25+) represents the stock of human capital. Higher education levels are associated with elevated per capita income and greater lifetime income potential. When aggregated in MSAs, increased educational attainment predicts higher mean income per capita. The data for the education variable were obtained from the 2006 American Community Survey.

It is important to note that different kinds and levels of education may have varying degrees of impact on per capita income. For this reason, the education variable was constructed using weights.[7] Graduate degrees were assigned a weight of 2.0. Bachelor degrees received a weight of 1.0. Associate degrees were weighted by 0.5 and some college (at least one year) was given a weight of 0.25. Once weighted, the values

[7] The weights were the same as those developed and used by the Kauffman Foundation for the State New Economy Index (Atkinson, 2007).

for each level of education were summed. To compensate for MSAs of different sizes, the education variable was normalized to the total population age 25 or over. The data used for MSAs was slightly different from that used for the KEI because Master's degrees and PhDs were not differentiated. In the KEI, Master's were weighted by 2.0 and PhDs by 2.5.

Fast growth firms are representative of the entrepreneurial environment of MSAs. As Watkins explains in his paper on the KEI, fast growth firms are a "marker species," a variable that indicates the presence of efficient policies for the establishment of new firms and the resources available for their development. In addition, fast growth firms are associated with increased employment. Because of the innovative nature of fast growth firms, many of these jobs added are high-tech that forms a vital aspect of the Knowledge Economy. Hence, more fast growth firms are an indicator of higher income per capita. Fast growth firms are expected to have a more significant effect on MSAs because closer geographic proximity will result in more immediate knowledge spillovers.

The variable for fast growth firms was constructed using data from the Inc. 500 and the Deloitte Technology Fast 500 lists. The number of fast growth firms from both lists was normalized by the total number of firms in order to weight the MSAs by size. The KEI used the same construct for its fast growth firms variable.

Research and development is a vital aspect of the knowledge economy. Academic R&D and industrial R&D, however, affect the economy differently. The primary purpose of academic R&D is to educate future scientists and engineers. Though much of the work may be patented and some may even be commercialized, that is not the main goal of the research activity. On the other hand, the entire focus of industrial R&D is the development of products that can be brought to market. The KEI used industrial R&D as a measure of innovation, but this data was not available on the MSA level; therefore, academic R&D was chosen as the substitute. Academic R&D is not expected to have as strong an effect as industrial R&D on mean income per capita, but it is anticipated to have a positive impact on income per capita.

The academic R&D variable was constructed using data from the National Science Foundation reporting of R&D funding by universities in 2006. The universities were associated with their respective MSAs in order to sum the dollar amount spent on R&D in each area. This quantity was divided by total personal income to compensate for differences between MSAs. The same methodology was used to build the industrial R&D variable for the KEI.

Median age is used as the control variable. Income generally increases with age through skill accumulation and work experience, so income per capita should be normalized using median age. The KEI used the same measure as a control variable. The data for median age was provided by the 2006 American Community Survey.

Statistical Analyses

All MSAs

The first estimate was for the complete Southern MSA sample. The model is written as follows:

$$\text{Per capita income} = \alpha_0 + \alpha_1(\text{workforce education}) + \alpha_2(\text{fast growth firms}) + \alpha_3(\text{academic R\&D}) + \alpha_4(\text{median age})$$

Descriptive statistics for the sample are shown in Table 2. The results of the Ordinary Least Squares (OLS) regression are shown in Table 3.

Table 2: Descriptive Statistics for All MSAs

Variables	**Mean**	**Std. Dev.**	**Min**	**Max**
Control				
Median Age (years)	36.049	4.020	25.2	51.2
Dependent				
Per Capita Income ($)	55872.72	7872.945	38869	85326
Independent				
Workforce Education	0.397	0.087	0.222	0.691
Fast Growth Firms	0.0000406	0.0000984	0	0.000808
Academic R&D	5.870	15.763	0	107.588

Table 3: Regression Results for All MSAs

Regressor	**Coefficient**	**Elasticities**	**T-statistic**
Workforce Education	717.69	0.510	10.6***
Fast Growth Firms	820.72	0.006	1.57
Academic R&D	-148.70	-0.016	-3.95***
Median Age	393.15		3.07**
Constant	13750.25		2.78
Summary Statistics			
Observations	114		
F-statistic	44.78		
R-squared	0.6217		

***1% significance level
**5% significance level
*10% significance level

Workforce Education divided by 100
Fast Growth Firms divided by 10000

Workforce education is the most significant variable in determining income per capita, which demonstrates that as a part of the knowledge economy, education is the most important factor to affect MSAs. For a 100% increase in the level of workforce education, mean income per capita will rise 51%, a relatively inelastic effect on this variable. Recall that the education variable is a composite variable that is measured by weighting the degree of education, and then summing the value of each level. For example, the number of bachelor's degrees (which have a weight of 1.0) in the Greenville MSA is 66,496. If that number were to double, it could raise mean income per capita in Greenville from $56,061 to $63,685 (this is calculated by multiplying the elasticity by the ratio of the weight of bachelor's degrees to total weights). That would mean that if the population with some college finished their degrees, the mean income per capita in the Greenvlle MSA would increase by almost $8,000.

The mean and standard deviation of the education variable are both comparable to the descriptive statistics found in the KEI.[8] The regression results for the education variable are similar to those found in the KEI, but the coefficient is almost doubled for this analysis. The t-statistic is also doubled, so while workforce education is significant at the 5% level for states, it is significant at the 1% level for MSAs.

The fast growth firms variable is not significant in this regression. In the KEI, a strong relationship was found between fast growth firms and mean income per capita. The difference may be due to the small sample of MSAs, but it could also evidence the hypothesis that another variable to measure entrepreneurial environment for MSAs would

[8] The minimum and maximum statistics show, however, that MSAs have a wider range of values for education, which is expected in larger samples.

be more useful. The mean and standard deviation of the fast growth variable are much higher (more than double) in the KEI analysis, which is expected since Watkins is measuring the number of companies on the list in each state versus the smaller geographical unit MSA. It is interesting, however, that these MSA results show a higher maximum than the KEI, which implies that one MSA in 2006 has more fast growth firms than any of the states on the 2005 list when weighted for total firms.

The R&D variable is where the model used in this analysis and the KEI differ the most. The KEI found industrial R&D to be positively correlated with mean income per capita, but when combined in a model with education, the relationship was comparatively insignificant. In this model, academic R&D was significant at the 1% level, but the coefficient was negative. For a 100% increase in academic R&D, mean income per capita will decrease by 1.6%. Since academic R&D is a proxy variable, it cannot be compared to Watkins' industrial R&D measure.

The negative correlation between academic R&D and mean income per capita can be explained by a combination of two factors. First, academic R&D may not positively influence the income per capita because the profits from research are dispersed with the new scientists and engineers when they have graduated. Though there are advantages to academic R&D on a larger geographical scale, the immediate area does not benefit directly. Second, the relationship is likely negative due to the large student population in MSAs with research universities. Students generally have a lower income than the general population. A neutral effect combined with a negative one result in a significant and negative coefficient.

The control variable, median age, was significant at the 1% level as well. Like in the KEI, this indicates that age is a useful control variable in regressions of income per capita.

MSAs in Neighboring States

The second estimate focused on a subset of MSAs located in South Carolina, North Carolina, Georgia, Tennessee and Alabama. The subsample is listed in Table 4.

Table 4: MSAs in Subset of SC, NC, GA, TN, and AL

MSA	State	MSA	State
Anniston	AL	Greensboro-Winston-Salem-High Point	NC
Auburn-Opelika	AL	Greenville	NC
Birmingham	AL	Hickory-Morganton-Lenoir	NC
Decatur	AL	Jacksonville	NC
Dothan	AL	Raleigh-Durham-Chapel Hill	NC
Florence	AL	Rocky Mount	NC
Gadsden	AL	Wilmington	NC
Huntsville	AL	Charlotte-Gastonia-Rock Hill	NC-SC
Mobile	AL	Charleston-North Charleston	SC
Montgomery	AL	Columbia	SC
Tuscaloosa	AL	Florence	SC
Albany	GA	Greenville-Spartanburg-Anderson	SC
Athens	GA	Myrtle Beach	SC
Atlanta	GA	Sumter	SC
Columbus	GA	Jackson	TN
Macon	GA	Knoxville	TN
Savannah	GA	Nashville	TN
Augusta-Aiken	GA-SC	Memphis	TN-AR-MS
Asheville	NC	Chattanooga	TN-GA
Fayetteville	NC	Clarksville-Hopkinsville	TN-KY
Goldsboro	NC	Johnson City-Kingsport-Bristol	TN-VA

The descriptive statistics for the subsample are shown in Table 5.

Table 5: Descriptive Statistics for MSAs in Neighboring States

Variables	Mean	Std. Dev.	Min	Max
Control				
Median Age (years)	35.910	3.225	25.2	41.5
Dependent				
Per Capita Income ($)	54739.9	6962.272	41190	73270
Independent				
Workforce Education	.405	.078	.274	.609
Fast Growth Firms	.0000317	.0000621	0	.000298
Academic R&D	5.628	12.541	0	63.962

There are several notable differences in the descriptive statistics for this subset. First, the median age is lower. This change is likely due to taking out Florida MSAs, where there are large retirement communities. In this subset of MSAs, mean workforce education is negligibly higher, but the means for fast growth firms and academic R&D are lower. Taking out Texas MSAs is the probable explanation for the lower variable means, as Austin, Dallas, and Houston all have high values for these measures. Per capita income is significantly lower is this subset, with a more than $1000 difference. Poverty-ridden areas in Alabama and Tennessee may be the source of this disparity.

The results of the Ordinary Least Squares (OLS) estimate for this subset are reported in Table 6.

Table 6: Regression Results for MSAs in Neighboring States

Regressor	Coefficient	Elasticities	T-statistic
Workforce Education	758.63	0.562	6.81***
Fast Growth Firms	301.00	0.017	2.75***
Academic R&D	-163.13	-0.017	-2.4**
Median Age	193.71	0	0.91
Constant	16995.29	0	1.88
Summary Statistics			
Observations	42		
F-statistic	23.83		
R-squared	.7204		

***1% significance level
**5% significance level
*10% significance level

Workforce Education divided by 100
Fast Growth Firms divided by 100000

Like the regression on the entire sample of MSAs, education was, by far, the most significant contributor to income per capita in the knowledge economy. The coefficient from this estimation is slightly higher (by approximately 5.6%), but the significance is lower for this subset. The t-statistic for this smaller set of MSAs is much closer to Watkins' result in the KEI, but the role of workforce education is still clear. The elasticity, like the coefficient, is slightly higher, which means that a comparable addition of bachelor's degrees to the Greenville MSA would result in a larger increase in income per capita according to this estimation.

Academic R&D had a significant, but negative, effect on income per capita as in the original regression. The coefficients are close in value and the significance is similar.

The primary difference is that academic R&D is significant at the 5% level for this subset, while the large sample had a 1% significance level. The elasticity resulting from this estimation is also comparable.

The key difference in this analysis was the fast growth firms variable. When the sample was limited to MSAs in states surrounding and including South Carolina, fast growth firms became a significant factor at the 1% level. Not only did the t-statistic nearly double, but the coefficient tripled. This result indicates that fast growth firms are a vital part of economies in and around South Carolina.

The elasticity also tripled, from .006 to .017. This means, for example, that if the number of fast growth firms in Greenville doubled from four to eight firms, with the number of total firms held constant, mean income per capita would increase by 1.7%, or approximately $850. Though this estimate may seem small for such a significant change, recall that fast growth firms are a proxy for entrepreneurial environment. If the number of companies on the Inc. 500 and Deloitte Tech Fast 500 were to double in the Greenville MSA, it would evidence a more significant change in the entrepreneurial environment. Such a change in the attractiveness of Greenville to entrepreneurs would have far reaching effects in comparison to the number of fast growth firms.

Another notable difference in this subset was the significance of the median age variable. For this regression, median age was not significant, indicating that it is not a good tool to normalize the differences between MSAs at this geographical proximity. The more narrow range of values for median age combined with this result suggest that there is not an important difference in age across this area that would affect income per capita.

SC MSAs

South Carolina MSAs were analyzed separately in order to better understand how they fit with the model and to compare them to the rest of the Southern MSAs. This subset is listed in Table 7.

Table 7: South Carolina MSAs

MSA	State
Augusta-Aiken	SC-GA
Charleston-North Charleston	SC
Charlotte-Gastonia-Rock Hill	SC-NC
Columbia	SC
Florence	SC
Greenville-Spartanburg-Anderson	SC
Myrtle Beach	SC
Sumter	SC

The descriptive statistics for South Carolina MSAs are in Table 8.

Table 8: Descriptive Statistics for SC MSAs

Variables	Mean	Std. Dev.	Min	Max
Control				
Median Age (years)	37.033	1.422	35.7	39.7
Dependent				
Per Capita Income ($)	55219.33	5840.114	48792	64131
Independent				
Workforce Education	.402	.066	.328	.490
Fast Growth Firms	.0000729	.000116	0	.000298
Academic R&D	4.056	4.638	0	9.522

There are several differences between South Carolina MSAs and the rest of the sample. First, South Carolinians are older. Though they are only a year older than the average MSA in the South, the median age in South Carolina is two years older than the mean for the MSAs in neighboring states. Since median age is supposed to normalize for income across MSAs, this result should indicate that South Carolina has higher per capita income. The opposite, however, is true. South Carolina does have higher per capita income than the subset of neighboring MSAs, but it is still $600 lower than the mean across Southern MSAs.

In the independent variables, South Carolina has negligibly higher workforce education. This finding means that South Carolinians have average education in comparison to other Southern states. In fast growth firms, however, South Carolina is soaring over the sample mean. While the mean for the entire sample set is .0000406, and the mean for the subset of neighboring MSAs is .0000317, South Carolina has a value of .0000729. In comparison to other Southern MSAs, and especially those in neighboring states, South Carolina has a much better entrepreneurial environment to attract fast growth firms. The opposite is true for academic R&D. South Carolina's MSAs lag behind both the sample mean of the entire set and that of the subset by a significant amount. For this analysis, however, the negative coefficient for academic R&D should increase the estimated income per capita for South Carolina.

Residual Analysis

In an effort to probe deeper into the estimates, the residuals of the estimate performed on the sample of all MSAs were examined to identify outliers, which can sometimes reveal omitted variables. Table 9 shows the descriptive statistics of the residuals.

Table 9: Residuals for All MSAs

Variable	Mean	Std. Dev.	Min	Max
Income Per Capita	55872.72	7872.945	38869	85326
Predicted	55872.72	6207.644	40534.38	74944.98
Residuals	0.0000211	4842.358	-9633.201	19825.13

The outliers, defined by the estimations of per capita income that were more than one standard deviation away from the actual values, are shown in Tables 10 and 11. Note that every MSA in Table 10 is the location of a major university. The over prediction suggests the importance of having educated people connected to income producing activities, which is not the case for the bulk of graduate students at universities.

Table 10: Outliers- Over Prediction

MSA	State	MeanIPC	Predicted	Residuals
Auburn-Opelika	AL	51166	58098.64	-6932.638
Gadsden	AL	41190	50823.2	-9633.201
Gainesville	FL	53681	62369.46	-8688.456
Tallahassee	FL	56403	62998.91	-6595.914
Lexington	KY	60658	67205.67	-6547.67
Hattiesburg	MS	49336	56771.7	-7435.698
Asheville	NC	55046	63162.43	-8116.431
Greenville	NC	50018	59154.06	-9136.062
Johnson City-Kingsport-Bristol	TN-VA	46392	55611.05	-9219.047

Table 11: Outliers- Under Prediction

MSA	State	MeanIPC	Predicted	Residuals
Fort Pierce-Port St. Lucie	FL	65628	59044.67	6583.328
Naples	FL	85326	65500.87	19825.13
Atlanta	GA	73270	65733.48	7536.514
Houma	LA	54800	43379.43	11420.57
Lafayette	LA	60556	54204.82	6351.177
Jackson	MS	67596	61045.8	6550.196
Raleigh-Durham-Chapel Hill	NC	72571	66271.32	6299.679
Dallas-Fort Worth-Arlington	TX	71935	61133.29	10801.71
Houston-Galveston-Brazoria	TX	70419	59319.5	11099.5
Victoria	TX	57492	49080.41	8411.594
Waco	TX	47534	40534.38	6999.626

Of the 19 MSAs that are more than one standard deviation away from the predicted value, none of these outliers were SC MSAs, which indicates that the model is effective in predicting income per capita for SC. Texas, on the other hand, had four outliers, all of which were under predicted. This result clearly indicates that there is an omitted variable that is important in Texas MSAS. Florida also seems to be poorly modeled with four outliers, two over predicted and two under. The two Florida MSAs that were under predicted are both retirement communities. Naples is also the only MSA more than two standard deviations away from the predicted value, which is likely due to its wealthy retirees. The Naples MSA has the highest mean income per capita in the sample.

Table 12 reports the residuals from the estimate of MSAs in neighboring states. Outliers are reported in Tables 13 and 14. Once again, all of the over predicted MSAs are cities with major universities.

Table 12: Residuals for Neighboring MSAs

Variable	Mean	Std. Dev.	Min	Max
Income Per Capita	54739.9	6962.272	41190	73270
Predicted	54739.9	5909.261	45212.19	67968.89
Residuals	.00000745	3681.556	-7675.839	6105.939

Table 13: Outliers- Over Prediction

MSA	State	MeanIPC	Predicted	Residuals
Auburn-Opelika	AL	51166	57243.45	-6077.449
Gadsden	AL	41190	47663.45	-6473.451
Greenville	NC	50018	57693.84	-7675.839
Greenville-Spartanburg-Anderson	SC	56061	62460.88	-6399.874
Johnson City-Kingsport-Bristol	TN-VA	46392	52626.39	-6234.389

Table 14: Outliers- Under Prediction

MSA	State	MeanIPC	Predicted	Residuals
Raleigh-Durham-Chapel Hill	NC	72571	66465.06	6105.939
Charlotte-Gastonia-Rock Hill	NC-SC	68712	62734.95	5977.053

There are seven MSAs that are more than one standard deviation away from the predicted value for MSAs in neighboring states. In contrast to the last model, two SC MSAs were on the list of outliers, indicating that the estimations based on strictly neighboring states are not as accurate for SC, which was also suggested by the difference in the descriptive statistics of SC MSAs in comparison to MSAs in neighboring states. It is interesting to note that, excepting the two SC MSAs, all of the outliers in this test were also outliers in the last one. This observation likely means that the other five MSAs have reasons for being outliers unrelated to the sample, while SC MSAs are better fitted by the previous estimation on all MSAs.

Education Variable

Many knowledge economy indices have found a strong relationship between education and income per capita. In order to distinguish which degree of education is responsible for this relationship, the education variable was analyzed from several different statistical points of view. First, it was broken down into its composite pieces. The OLS results are shown in Table 15.

Table 15: Regression Results of Education Pieces

Regressor	Coefficient	Elasticities	T-statistic
Some College	424.585	0.157	2.23**
Associate's Degree	-206.791	-0.027	-0.69
Bachelor's Degree	131.019	0.349	6.7***
Graduate Degree	699.296	0.100	2.6***
Fast Growth Firms	409.729	0.003	0.78
Academic R&D	-93.403	-0.010	-2.35**
Median Age	521.399		4.11***
Constant	5060.906		0.8
Summary Statistics			
Observations	114		
F-statistic	30.62		
R-squared	0.6691		

***1% significance level
**5% significance level
*10% significance level

Some College divided by 100
Associate's Degree divided by 100
Bachelor's Degrees divided by 1000
Graduate Degrees divided by 100
Fast Growth Firms divided by 10000

Because of the issue of multicollinearity, the results must be analyzed with caution. First, some college has a high coefficient and is significant at the 5% level. This result suggests that simply having a large percentage of the population that has graduated from high school will boost income per capita. Associate’s degrees are not significant when analyzed separate from the other education components, which indicates that this type of degree has no effect on the mean income per capita. Bachelor’s degrees, as expected, are significant at the 1% level. Though this component has a much lower coefficient than some college, it is indicative of an important relationship between college graduates and income per capita. The component that stands out in this analysis is graduate degrees. It is significant at the 1% level and has the highest coefficient of all of the education measures.

To eliminate the multicollinearity problem, levels of education were regressed separately. College degrees and graduate degrees were combined (college being a prerequisite for graduate) and weighted by the workforce population of the MSA to analyze the effect of this level of education on the mean income per capita. The results are reported in Table 16.

Table 16: Regression Results with College Degrees

Variable	Coefficient	Elasticities	T-Statistic
College Degrees	107.333	0.220	11.23***
Fast Growth Firms	405.951	0.003	0.78
Academic R&D	-140.562	35.841	-3.92***
Median Age	433.643		3.51***
Constant	16313.31		3.46
Summary Statistics			
Observations	114		
F-statistic	49.33		
R-squared	0.6442		

***1% significance level
**5% significance level
*10% significance level

College Degrees divided by 1000
Fast Growth Firms divided by 10000

The coefficient on the education variable using strictly college and graduate degrees was about one and half times the original education variable. In comparison with the analysis of education by components, college degrees have a similar coefficient in this regression and are also significant at the 1% level. Fast growth firms remained insignificant in this analysis and academic R&D had a coefficient and t-statistic very close to those from the original regression with the weighted education variable.

Table 17 reports the results of running the regression with graduate degrees only as the education variable.

Table 17: Regression Results with Graduate Degrees

Variable	Coefficient	Elasticities	T-Statistic
Graduate Degrees	187.102	0.269	7.6***
Fast Growth Firms	161.000	0.012	2.77**
Academic R&D	-157.257	-0.016	-3.37***
Median Age	404.341		2.73**
Constant	26550.86		4.92
Summary Statistics			
Observations	114		
F-statistic	26.99		
R-squared	0.4976		

***1% significance level
**5% significance level
*1% significance level

College Degrees divided by 1000
Fast Growth Firms divided by 10000

The coefficient on the graduate degrees was more than two and a half times that of the original education variable. This finding supports graduate degrees as being the key determinant of the education variable. The fast growth firms variable becomes significant for the first time in this analysis, which suggests that the original education variable is simply dominating the effects of other variables on mean income per capita. It is also interesting to note that academic R&D continues to be significant with only the graduate component of the education variable operating in the model. This result confirms the earlier explanation that academic R&D may be a proxy for the presence of a lower income student population. To further explore this point, a regression was run with the education variable omitted. The results are shown in Table 18.

Table 18: Regression of All MSAs without Education Variable

Regressor	Coefficient	Elasticities	T-statistic
Fast Growth Firms	320.00	0.023	4.77***
Academic R&D	59.93	0.006	1.32
Median Age	634.47		3.55***
Constant	31351.33		4.75
Summary Statistics			
Observations	114		
F-statistic	11.07		
R-squared	0.2319		

***1% significance level
**5% significance level
*10% significance level

Fast Growth Firms divided by 100000

There are two interesting results from this regression. First, fast growth firms are a determinant of mean income per capita but, as the above analysis suggested, the effect is dominated by the presence of the education variable. Without education in the equation, fast growth firms are significant at the 1% level. Second, when education is no longer in the analysis, academic R&D becomes insignificant as a determinant of mean income per capita. This result indicates that academic R&D is adjusting the effect of workforce education on income per capita and is, thus, substituting for a more revealing variable. Further analysis is necessary to determine the cause of this effect.

Index Construction

This index for MSAs was built using the same methodology as the KEI. The coefficients from the regressions results were used as weights to determine the final index value. Each of the three variables were multiplied by their respective coefficient for each MSA, and then summed. The results for the top 15 MSAs from the full sample are shown in Table 19. The full listing is reported in Appendix 3.

Table 19: Top 15 MSAs

MSA	State	Rank
Austin	TX	1
Charlottesville	VA	2
Lexington	KY	3
Raleigh-Durham-Chapel Hill	NC	4
Atlanta	GA	5
Huntsville	AL	6
Gainesville	FL	7
Tallahassee	FL	8
Charlotte-Gastonia-Rock Hill	NC-SC	9
Richmond-Petersburg	VA	10
Fort Walton Beach	FL	11
Columbia	SC	12
Naples	FL	13
Dallas-Fort Worth-Arlington	TX	14
Jackson	MS	15

Austin, TX is the number one MSA in this index, which suggests that it is the Knowledge Economy capital of the South. With its reputation as a research center and the respected universities in the area, Austin is able to attract an educated workforce and innovative firms. Raleigh-Durham, NC is another important center of research that makes the top of the list. This result is expected considering Raleigh-Durham's place in the Research Triangle. Filling out the top five are Charlottesville, Lexington, and Atlanta, which are all highly populated metropolitan areas where educated minds, entrepreneurial firms and research can all be geographically centered.

Two MSAs in South Carolina make the top 15 list: Charlotte-Gastonia-Rock Hill and Columbia. The majority of the Charlotte MSA is located in North Carolina, so Columbia is the center of the Knowledge Economy in South Carolina. In recent years, Columbia has seen the development of a significant ring of knowledge-based firms. In addition, the University of South Carolina has led an effort to attract research-based firms that will link their work to the marketplace.

The index was then constructed using the coefficients from the neighboring MSAs analysis. The top 5 MSAs from the neighboring MSAs index are listed in Table 20.

Table 20: Top 5 Neighboring MSAs

Rank	MSA	State	Total
1	Atlanta	GA	44277
2	Huntsville	AL	43201.1
3	Raleigh-Durham-Chapel Hill	NC	42750.9
4	Charlotte-Gastonia-Rock Hill	NC-SC	38884.1
5	Greenville-Spartanburg-Anderson	SC	38366.4

Most of the MSAs that are on this list are also in the top 15 of the index of all Southern MSAs. The Greenville-Spartanburg-Anderson MSA is the only exception and it takes Columbia's place as the second MSA at the top of the list. This difference is due to the higher coefficient on the fast growth firms variable in this analysis, which allows Greenville to overtake Columbia. This is also the likely reason that Atlanta and Huntsville are ranked higher than Raleigh-Durham in this index.

Table 21 shows the ranks of all South Carolina MSAs in both indices.

Table 21: SC MSAs

MSA	State	Rank 1	Rank 2
Charlotte-Gastonia-Rock Hill	NC-SC	9	4
Columbia	SC	12	5
Charleston-North Charleston	SC	22	8
Greenville-Spartanburg-Anderson	SC	39	17
Augusta-Aiken	GA-SC	54	21
Myrtle Beach	SC	56	22
Sumter	SC	83	34
Florence	SC	89	36

Rank 1: All MSAs Index
Rank 2: Neighboring MSAs Index

The two indices show almost identical relative rankings for SC MSAs, again enforcing its validity for application to South Carolina. The only MSA that moves in ranking between the two indices is Greenville-Spartanburg-Anderson. In the index using the coefficient from the regression on all MSAs, the Greenville MSA ranks 5th. On the other hand, the Greenville MSA ranks 2nd using the coefficients from the regression on neighboring MSAs. Once again, this is likely due to the different emphasis on fast growth firms between the two indices.

Comparative Rankings

The results of this index were tested against other respected indices in order to compare the findings. To have a common sample, it was necessary to re-rank each MSA according to the relevant subset for analysis. This index is compared to the Milken Institute's Best Performing Cities Index (DeVol et al, 2008), Richard Florida's Creativity Index (Florida, 2002), and the KEI (Watkins, 2008).

The Milken Institute is a think tank that publishes a variety of reports that measure the economic performance of states and MSAs. The purpose of the Best Performing Cities Index is to determine which MSAs are experiencing employment growth and maintenance. Though the primary factors in the index are job and wage growth, Milken also includes several measures of the high tech industry to determine a MSAs' participation in the Knowledge Economy. The index is composed of nine factors that are weighted based on Milken's determination of relative importance. The ranks are based on two subsets of MSAs: large and small. The top 200 MSAs with the largest number employed are classified as large MSAs. All other MSAs are termed small MSAs. See Appendix 4 for a full listing of the comparative ranks.

The OLS results for the regression of Milken's rankings on the rankings developed in this study are reported in Table 22 and 23.

Table 22: Regression on Milken's Rankings- Large

Regressor	Coefficient	T-Statistic
Milken Rank	0.229	1.94*
Summary Statistics		
Observations	70	
F-Statistic	3.78	
R-Squared	0.053	
*10% Significance Level		

Table 23: Regression on Milken's Rankings- Small

Regressor	Coefficient	T-Statistic
Milken Rank	0.480	2.74**
Summary Statistics		
Observations	27	
F-Statistic	7.5	
R-Squared	0.2308	
**5% Significance Level		

Both of the regressions found a significant relationship between the Milken Institute's Index and this index; however, neither had a high R-squared. The Milken rankings on small MSAs were more highly correlated with the rankings from this index with larger R-squared. Small MSAs were also significant at the 5% level, versus the 10% level with large MSAs. This result indicates that the variables such as high-tech jobs and employment growth may measure similar effects as workforce education and academic R&D in the economies of smaller MSAs.

Next, the rankings from this index were compared to the index built in Richard Florida's (2008) book The Rise of the Creative Class. Florida approaches the measurement of the economy from a unique perspective that emphasizes the importance of a MSAs' ability to attract a "creative" workforce. Some of the employment categories that Florida isolates as a vital factor in the growth of the economy are scientists and engineers, artists, musicians, novelists, professors, designers, and architects. These occupations promote innovation, which is also identified in this index as an important factor in the new Knowledge Economy. The full list of comparative rankings is in Appendix 5.

The OLS results are shown in Table 24.

Table 24: Regressions on Florida's Creativity Rank

Regressor	Coefficient	T-Statistic
Creativity Rank	0.627	7.68***
Summary Statistics		
Observations	93	
F-Statistic	58.97	
R-Squared	0.393	
***1% Significance Level		

There is a relatively strong correlation between Richard Florida's Creativity Index and this index. The relationship is significant at the 1% level, but the R-squared statistic does not demonstrate an ability of the Creativity rankings to explain the rankings from this study. These results suggest that the creativity measures in Florida's index are an important aspect of the knowledge economy, but they are not the only factor.

The final index comparison is with the state rankings from the KEI. The Southern states were re-ranked from the KEI for comparison. The index values for the MSAs in each state were averaged to find an index value for the state. The states were ranked based on this value. The comparative rankings are listed in Table 25.

Table 25: Ranks Compared to the KEI

State	Rank	KEI Rank
Florida	1	5
Virginia	2	1
Mississippi	3	10
Oklahoma	4	7
Georgia	5	2
South Carolina	6	6
North Carolina	7	4
Tennessee	8	8
Kentucky	9	11
Alabama	10	9
Texas	11	3
Louisiana	12	12
Arkansas	13	13

The OLS results for the comparison are shown in Table 26:

Table 26: Regression on the KEI

Regressor	Coefficient	T-Statistic
KEI	0.555	2.21**
Summary Statistics		
Observations	13	
F-Statistic	4.9	
R-Squared	0.308	
**5% Significance Level		

The regression results demonstrate a correlation between the rankings from the KEI and the rankings from this analysis. The relationship is significant at the 5% level, but the R-squared is low as in the other indices.

The more interesting results are through the examination of the table of rankings. Since this index was built using the methodology of the KEI, the comparison of rankings tests the relationship of MSAs to states. The similar rankings of states such as South Carolina, Tennessee, Louisiana, and Arkansas demonstrate that MSAs are the essential building blocks of states and their composite economy determines the direction of the state. Other states, such as Georgia, Florida, and Texas show very little relationship between the rankings of the state versus that of particular MSAs. These states are dominated by the larger MSAs and the economy of the state is not reflected by that of the MSA. Further analysis is necessary to determine the extent of this relationship.

Discussion

Overall, this project succeeded in replicating the methodology used in Watkins' KEI for states and applying it to MSAs. The analyses of the results suggest that, although the overall methodology is applicable for MSAs, some of the variables are not as valuable as measures in smaller geographical units. The usage of regression results to determine weights certainly produces more robust index values; however, different determinants of the Knowledge Economy would be more useful for MSAs.

The fast growth firms variable was hypothesized to be more important at an MSA level because of more immediate knowledge spillovers; however, the analysis found fast growth firms to not be significant for MSAs. The effects of fast growth firms were more clearly dominated by workforce education at the MSA level than they were at the state level. For a future index of MSAs, a better measure of entrepreneurial environment should be found.

Industrial R&D is the one measure from the KEI that could not be replicated for this index. It is also the variable that affected the index value negatively, instead of its hypothesized positive effect. Through the analysis of the workforce education variable and residuals analysis, this negative coefficient was explained as a substitute for an omitted variable that would more accurately proxy for innovation. A different determinant for innovation should be used for future indices for MSAs.

Workforce education appears to be a universally applicable variable for measuring the stock of knowledge in an economy. Its significance at a 1% level and large relative coefficient demonstrates its validity and the theory for human capital supports its usage. Geographical proximity does not affect the value of education as a determinant of income per capita.

This analysis also examined workforce education to determine what part of this composite variable was responsible for the large effect on income per capita. The education by parts regression results suggest that simply graduating from high school and attempting some college, regardless of achievement level, is important for determining income per capita. However, by only looking at college degrees, the coefficient on the education variable was 50% higher than in the original analysis. When the education variable was further isolated to graduate degrees, the effect on income per capita was more than two and a half times that of the original result. This finding supports graduate degrees, which are often research based, as the most important factor in the Knowledge Economy.

Another interesting result of the education variable was determining how its dominating effect was affecting the other measures of the Knowledge Economy. Two findings emerge. First, the fast growth firms variable is important in the Knowledge

Economy; however, the significance of education is much larger. This result is evidenced by the growing importance of the fast growth firms variable as the components of the education variable are isolated and, especially, when workforce education is taken out of the equation completely. Second, academic R&D appears to be adjusting the effects of workforce education, suggesting that another measure of innovation would be more valuable. After being significant at the 1% level for the rest of the analyses, when academic R&D is regressed with fast growth firms alone on income per capita, it is no longer significant.

This role of academic R&D is supported by the residuals analysis, which suggests that there is an omitted variable. All of the MSAs that have over-predicted index values are college towns, without exception. This result is despite the fact that college towns certainly have higher than average values for academic R&D, which has a negative coefficient. There is evidently some aspect of college towns that is not accounted for in this analysis, which suggests that there is an omitted variable. Further analysis is necessary to determine what this variable might be.

The analysis on comparative rankings also revealed a pattern. Though there is little correlation between this index and the other relevant indices, when MSAs are recomposed to imitate a state index to compare to Watkins' KEI, an unsuspected outcome emerges. There is a correlation, but it is no higher than the comparisons to other indices. If the comparison is not statistically analyzed, simple observation shows that while some rankings are identical, others differ by a significant amount. This division of states could also be analyzed as partitioning the states with and without dominating MSAs. While

Georgia with the Atlanta MSA is not comparable to Georgia as a state, South Carolina is equivalent as a composite of MSAs and as a state. Once again, further analysis is necessary to flush out this difference. The next chapter will discuss all of the proposed analyses based on the results of this study.

Chapter 3

CONCLUDING REMARKS

Towards an Improved Index

This study has been an effort to replicate the methodology of Watkins' KEI for Southern MSAs. During the analysis of this experiment, several interesting questions arose. This section will suggest a direction for further study and propose some issues for future experiments. First, the inclusion of non-Southern MSAs will be discussed. Then, improvements to the current measures will be suggested. This chapter will next examine the prospect of additional variables and propose statistical models for future estimation. Finally, this chapter will discuss other questions arising from this analysis that require further investigation.

Full Sample of MSAs

In order to build an index by which South Carolina cities can be compared to the nation, it will be necessary to re-estimate the model with a nation-wide sample of MSAs. With the additional data covering all of the U.S., conclusions from this report can either be strengthened or the new information could suggest additional paths of study. This expansion will require the addition of other variables to control for the differences in region, climate, homogeneity, or a variety of other factors.

There are several different ways to control for the exogenous factors that may affect income per capita across the nation. To hold geography constant, for example, one could include latitude lines, a dummy variable for region, or a dummy variable for state in the model. Climate could be controlled with the addition of mean temperature.

Another approach could be to perform a cluster analysis on the full sample of MSAs, similar to Barkley and Henry (2006). Then, a dummy variable for the clusters suggested by the analyses could be included in the model.

Improved Measures

Workforce education was determined to be the most influential factor of the knowledge economy on income per capita by both this study and Watkins' research. Further analysis revealed that graduate degrees are responsible for the largest degree of this weight. The knowledge variable should be replaced by an unweighted measure of graduate degrees in each MSA. This adjustment to the model would eliminate any relation to arbitrary weights.

Fast growth firms were not an important contributor to income per capita for most of this analysis. It was only in the neighboring MSAs analysis and when education was taken out of the equation that the fast growth firms variable became significant. Though the strength of workforce education is partially responsible, future indices should explore other options to represent the entrepreneurial environment for MSAs.

A variable for entrepreneurial environment could come from a variety of sources. New businesses could be measured from the number of business licenses issued or the percentage of firms that are less than five years old. The employment created by the entrepreneurial sector of the area could be determined by the percentage employment in businesses less than five years old, or with less than twenty employees. Venture or angel capital could also represent the entrepreneurial environment. It could be measured by the number of support organizations in the area, the expenditures of venture capita, either as a number or a percentage, or by the number of firms that are receiving it.

Industrial R&D was the variable for which there was no MSA data. As a substitute, academic R&D had the opposite sign of industrial R&D. This result suggested that, while academic R&D was a significant factor, it was a proxy for another variable associated with university cities. For future indices, a different measure of innovation should be used.

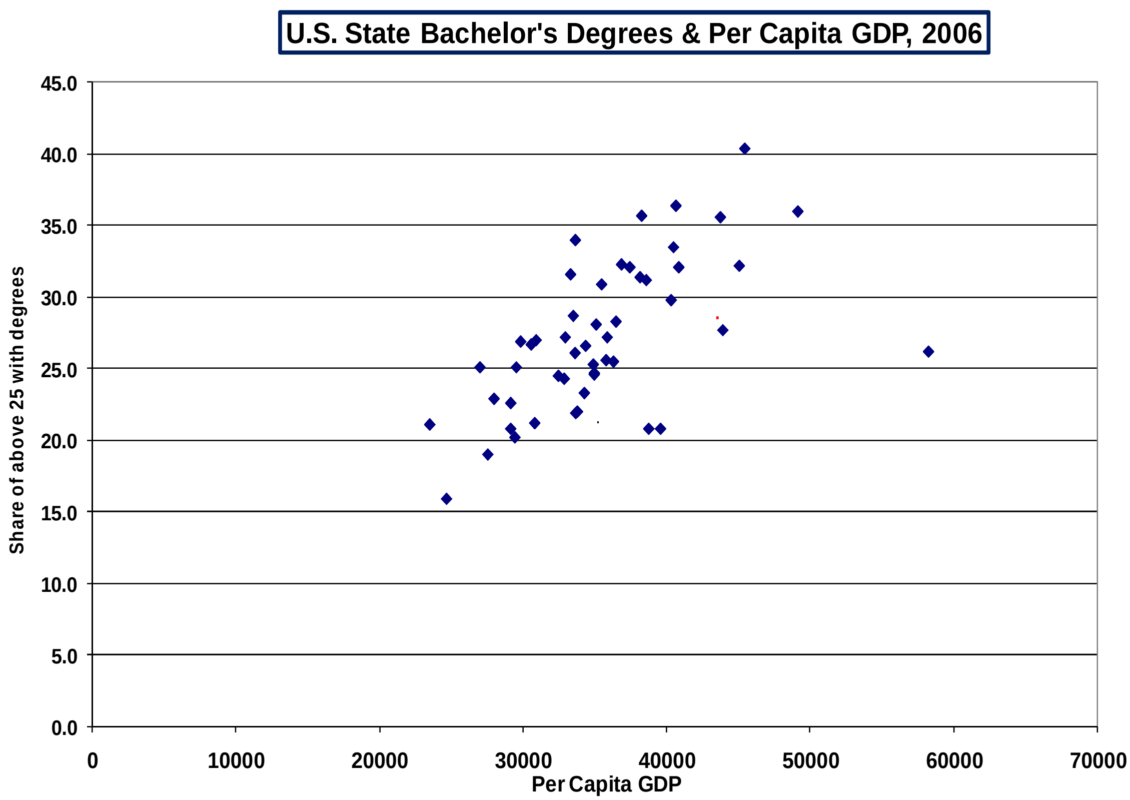
Though data for industrial R&D expenditures may not be available for MSAs, data on individual research laboratories is obtainable from the National Science Foundation. This data could be used as a proxy for total industrial R&D expenditures. Other options may be to use the percentage of employment in R&D laboratories or the percentage of employment of scientists and engineers. The number of patents or the licensing of patents are also viable variables, but it is also suggested to account for the number of firms or individuals applying for patents. This control is to address the issue of a large number of patents being produced by just one or two firms.

Additional Measures

The model used in this experiment was based on the division of the Knowledge Economy into three primary determinants: knowledge, entrepreneurial environment, and innovation. There are three possible factors that should be further explored to determine their relevance to the comprehension of the Knowledge Economy. First, connectivity has not been accounted for in this model. Second, costs or standards of living could be an important contributor to the Knowledge Economy. In conjunction with costs and standards of living, migration patterns may also provide valuable information about the development of the Knowledge Economy.

While knowledge, entrepreneurship, and innovation are all vital aspects of the Knowledge Economy, if information is not communicated between the sectors, there is a limit to how much they can affect income per capita. Knowledge must be transferred to research laboratories or other think tanks in order to increase innovation. Innovation must then be conferred to the market for entrepreneurship. This connection is why networking is an additional determinant of the Knowledge Economy.

Recall Figure 1, which revealed the relationship between college degrees and GDP per capita.



One explanation for the states that are to the right of the predicted line is that they are better connected. Therefore, in addition to knowledge, policymakers must consider how to network the minds to the funding and then to the commercialization. The inclusion of a connectivity variable is expected to increase the explanatory power of the model.

Networking, or connectivity, can be measured several different ways. First, a direct measure of the amount of information flowing between individuals, the population that has cell phones, Facebook, MySpace, or Twittter could be included in the model. Business and professional services connect agents from different parts of the economy for an exchange; therefore, the percentage of the population employed in this sector could be used as a measure of networking. The number of business associations or unions could also measure connectivity.

The most mobile population in the U.S. are single, aged 25-39, with college degrees. As a large percentage of this demographic group contributes to the Knowledge Economy, aspects of a city that attract them could be an important determinant of income per capita. One contributor to the migration decisions of young singles, in addition to other demographic groups, is the cost and/or standards of living. These individuals are influence by how much their income can buy, and what effect non-monetary aspects of an area will have on them.

There are several possible measures of the costs of living. Median housing prices, any of several cost of living indices, or the price of a specific commodity are all viable options as a proxy. Standards of living can also be measured several different ways. Richard Florida (2008) has published several creativity indices, such as *Who is your*

City?, that could be used. There are also several indices published by different magazines and think tanks that determine a city's livability.

The final variable that should be considered as an addition to this index is migration. In conjunction with the costs or standards of living variable, the migration measure would signal which MSAs are attracting the mobile population. In other words, migration measures the attractiveness of a city, just as costs or standards of living do; the difference is that a people are communicating more information by voting with their feet. The specific group that is most interesting to the Knowledge Economy is single, aged 25-39, with a college degree, so this should be the targeted demographic group. Future indices should consider this variable, in addition to the costs or standards of living, and networking.

Future Statistical Models

For the estimation of an index for a nation-wide sample of MSAs, mean temperature is suggested to control for climate differences across the U.S.

$$\text{Per capita income} = \alpha_0 + \alpha_1(\text{workforce education}) + \alpha_2(\text{fast growth firms}) + \alpha_3(\text{academic R\&D}) + \alpha_4(\text{median age}) + \alpha_5(\text{mean temperature})$$

Mean temperature is proposed in lieu of latitude lines because both would estimate the same differences in distance from the equator, but temperature also accounts for differences in elevations. Regions and states are also more general in estimating climate than mean temperature. Though a control variable for regions and states would also account for different regulation, this model should not be controlled for variations in legislative environment since one of the aspects of analysis is policy making.

Next, a model using strictly the improved measures proposed by this analysis should be estimated using the full sample of MSAs.

$$\text{Per capita income} = \alpha_0 + \alpha_1(\text{graduate degrees}) + \alpha_2(\text{Entrepreneurship}) + \alpha_3(\text{Innovation}) + \alpha_4(\text{median age}) + \alpha_5(\text{mean temperature})$$

The appropriate measure for entrepreneurship and innovation should be determined by separate analyses that regress the differing measures on mean income per capita.

Finally, a model using the additional variables discussed above should be analyzed. Before this final model can be estimated, the relationship between costs and/or standards of living and migration patterns must be determined. If the two variables are highly collinear, they cannot both be included in the final model.

$$\text{Per capita income} = \alpha_0 + \alpha_1(\text{graduate degrees}) + \alpha_2(\text{Entrepreneurship}) + \alpha_3(\text{Innovation}) + \alpha_4(\text{Networking}) + \alpha_5(\text{Costs/Standards of Living}) + \alpha_6(\text{Migration}) + \alpha_7(\text{median age}) + \alpha_8(\text{mean temperature})$$

The new index for MSAs should use this statistical model (condition on non-collinearity) for future rankings.

Other Research

There are three results from the analysis in this paper that require further investigation. The first is the omitted variable associated with MSAs that have research universities. Academic R&D is negatively associated with income per capita according to this estimate. When workforce education is taken out of the equation, however, there is no significant correlation between academic R&D and income per capita. This result suggests that academic R&D is a proxy for an over-estimation of education. The analysis using the improved measures discussed above will provide more information on this omitted variable or specification problem.

Beyond improvements to the index for MSAs, further research is necessary to understand the phenomenon of university cities. Outside of this thesis, Barkley and Henry (2006) also find that university cities behave differently in their cluster analysis. To clarify, not all universities have a large impact on their communities. In order to be considered a university city, the university must be at the graduate level and research must be a primary focus. In addition, the university must be within the major city of the MSA. For example, Greenville is not considered a university city because Clemson University is located well outside of the city limits. Overall, MSAs with university cities should be explored separately from other MSAs.

Another result that should be the subject of future study is the relation between MSAs and the states in which they are located. The preliminary investigation in this paper suggested that states that were dominated by one major MSA were not well represented by state data. On the other hand, states that were made up by several MSAs of medium importance were better represented by state data. Future research should categorize states by the variance between MSAs, whether that is determined by population, GDP, or income. Then, the relationship between MSAs and states can be compared by their respective classes.

Finally, the effectiveness of the methodology used in this thesis should be compared to other methods of building indices. For example, using the data from this report, another index could be built using the techniques of "The Greater Greenville

Regional Economic Scorecard." By reranking states according to their relationship to the national average, the utility of each method could be determined. The comparison of the results from other methodologies such as box score and assigned weights could also provide evidence for the most efficient and accurate approach.

Conclusion

This thesis is an attempt to replicate the methods used Watkins' KEI to build an index for Southern MSAs. The same statistical methods were utilized, with almost identical variables. Workforce education and fast growth firms were both replicable; however, academic R&D was used as a proxy for industrial R&D. The statistical model was estimated for the full sample of MSAs and for the subsample of MSAs in South Carolina and surrounding states, with comparable results. Overall, the effort was successful in creating an index for MSAs and several useful results emerged from the analysis.

Workforce education was found to be the most significant determinant of income per capita in the Knowledge Economy, regardless of geographic proximity. When this variable was further broken down into its composite pieces, graduate degrees were found to be the most influential of the components. It is recommended that future indices use an unweighted measure of graduate degrees as a proxy for workforce education.

Fast growth firms were hypothesized to have a more significant effect on MSAs than states because the knowledge spillovers would be more immediate. The opposite, however, was found to be true. In the full sample, fast growth firms were not significant until education was taken out of the model, whereas Watkins' found this variable to be significant at the 5% level. Future indices should explore other options to measure the entrepreneurial environment relevant to the Knowledge Economy.

Academic R&D also did not behave as predicted. Instead of a lower positive coefficient, academic R&D had a significantly negative coefficient. The interaction between the workforce education variable and academic R&D suggest an omitted variable when measuring the Knowledge Economy of university cities. Further research is necessary to understand this relationship and a different measure of innovation should be used for future indices.

Overall, this thesis has accomplished its objective of replicating the methodology of the KEI; however, in the process, it has raised more questions than it has perhaps answered. Regardless, a thorough foundation has been laid for further research into the Knowledge Economy and for building future indices for MSAs.

APPENDICES

Appendix 1: Watkins KEI

State	Rank	Income	GDP	State	Rank	Income	GDP
Alabama	44	40	45	Montana	27	42	48
Alaska	20	13	5	Nebraska	22	29	20
Arizona	19	24	37	Nevada	45	16	11
Arkansas	49	48	47	New Hampshire	7	6	16
California	9	12	10	New Jersey	6	3	6
Colorado	4	8	8	New Mexico	31	46	40
Connecticut	5	1	2	New York	11	7	4
Delaware	14	14	1	North Carolina	28	32	21
Florida	30	18	35	North Dakota	29	35	33
Georgia	18	27	23	Ohio	35	28	28
Hawaii	23	11	17	Oklahoma	41	45	46
Idaho	32	44	42	Oregon	17	23	18
Illinois	16	15	13	Pennsylvania	26	21	27
Indiana	42	34	30	Rhode Island	15	17	22
Iowa	36	31	24	**South Carolina**	**39**	**39**	**44**
Kansas	21	26	34	South Dakota	37	38	26
Kentucky	47	41	43	Tennessee	43	37	29
Louisiana	48	47	39	Texas	25	36	19
Maine	34	30	41	Utah	13	43	38
Maryland	2	2	14	Vermont	12	19	31
Massachusetts	1	4	3	Virginia	3	5	7
Michigan	24	25	32	Washington	10	10	15
Minnesota	8	9	9	West Virginia	50	49	49
Mississippi	46	50	50	Wisconsin	33	20	25
Missouri	38	33	36	Wyoming	40	22	12

Appendix 2a: Listing of All MSAs by Primary City

MSA	State
Abilene	TX
Albany	GA
Alexandria	LA
Amarillo	TX
Anniston	AL
Asheville	NC
Athens	GA
Atlanta	GA
Auburn-Opelika	AL
Augusta-Aiken	GA-SC
Austin	TX
Baton Rouge	LA
Beaumont-Port Arthur	TX
Biloxi-Gulfport-Pascagoula	MS
Birmingham	AL
Brownsville-Harlingen-San Benito	TX
Bryan-College Station	TX
Charleston-North Charleston	SC
Charlotte-Gastonia-Rock Hill	NC-SC
Charlottesville	VA
Chattanooga	TN-GA
Cincinnati-Hamilton	OH-KY-IN
Clarksville-Hopkinsville	TN-KY
Columbia	SC
Columbus	GA
Corpus Christi	TX
Dallas-Fort Worth-Arlington	TX
Danville	VA
Daytona Beach	FL
Decatur	AL
Dothan	AL
El Paso	TX
Evansville-Henderson	IN-KY
Fayetteville	NC

MSA	State
Johnson City-Kingsport-Bristol	TN-VA
Jonesboro	AR
Killeen-Temple	TX
Knoxville	TN
Lafayette	LA
Lake Charles	LA
Lakeland-Winter Haven	FL
Laredo	TX
Lawton	OK
Lexington	KY
Little Rock-North Little Rock	AR
Long View-Marshall	TX
Louisville	KY-IN
Lubbock	TX
Lynchburg	VA
Macon	GA
McAllen-Edinburg-Mission	TX
Melbourne-Titusville-Palm Bay	FL
Memphis	TN-AR-MS
Mobile	AL
Monroe	LA
Montgomery	AL
Myrtle Beach	SC
Naples	FL
Nashville	TN
New Orleans	LA
Norfolk-Virginia Beach-Newport News	VA-NC
Ocala	FL
Odessa-Midland	TX
Oklahoma City	OK
Orlando	FL
Owensboro	KY
Panama City	FL
Pensacola	FL

Fayetteville-Springdale-Rogers	AR
Florence	SC
Florence	AL
Fort Myers-Cape Coral	FL
Fort Pierce-Port St. Lucie	FL
Fort Smith	AR-OK
Fort Walton Beach	FL
Gadsden	AL
Gainesville	FL
Goldsboro	NC
Greensboro-Winston-Salem-High Point	NC
Greenville	NC
Greenville-Spartanburg-Anderson	SC
Hattiesburg	MS
Hickory-Morganton-Lenoir	NC
Houma	LA
Houston-Galveston-Brazoria	TX
Huntington-Ashland	WY-KY-OH
Huntsville	AL
Jackson	MS
Jackson	TN
Jacksonville	FL
Jacksonville	NC

Pine Bluff	AR
Punta Gorda	FL
Raleigh-Durham-Chapel Hill	NC
Richmond-Petersburg	VA
Roanoke	VA
Rocky Mount	NC
San Angelo	TX
San Antonio	TX
Sarasota-Bradenton	FL
Savannah	GA
Sherman-Denison	TX
Shreveport-Bossier City	LA
Sumter	SC
Tallahassee	FL
Tampa-St. Petersburg-Clearwater	FL
Texarkana-TX-Tesarkana	AR
Tulsa	OK
Tuscaloosa	AL
Tyler	TX
Victoria	TX
Waco	TX
Wichita Falls	TX
Wilmington	NC

Appendix 2b: Listing of All MSAs by State

MSA	State
Anniston	AL
Auburn-Opelika	AL
Birmingham	AL
Decatur	AL
Dothan	AL
Florence	AL
Gadsden	AL
Huntsville	AL
Mobile	AL
Montgomery	AL
Tuscaloosa	AL
Fayetteville-Springdale-Rogers	AR
Jonesboro	AR
Little Rock-North Little Rock	AR
Pine Bluff	AR
Texarkana-TX-Tesarkana	AR
Fort Smith	AR-OK
Daytona Beach	FL
Fort Myers-Cape Coral	FL
Fort Pierce-Port St. Lucie	FL
Fort Walton Beach	FL
Gainesville	FL
Jacksonville	FL
Lakeland-Winter Haven	FL
Melbourne-Titusville-Palm Bay	FL
Naples	FL
Ocala	FL
Orlando	FL
Panama City	FL
Pensacola	FL
Punta Gorda	FL
Sarasota-Bradenton	FL
Tallahassee	FL
Tampa-St. Petersburg-Clearwater	FL
Albany	GA

MSA	State
Fayetteville	NC
Goldsboro	NC
Greensboro-Winston-Salem-High Point	NC
Greenville	NC
Hickory-Morganton-Lenoir	NC
Jacksonville	NC
Raleigh-Durham-Chapel Hill	NC
Rocky Mount	NC
Wilmington	NC
Charlotte-Gastonia-Rock Hill	NC-SC
Cincinnati-Hamilton	OH-KY-IN
Lawton	OK
Oklahoma City	OK
Tulsa	OK
Charleston-North Charleston	SC
Columbia	SC
Florence	SC
Greenville-Spartanburg-Anderson	SC
Myrtle Beach	SC
Sumter	SC
Jackson	TN
Knoxville	TN
Nashville	TN
Memphis	TN-AR-MS
Chattanooga	TN-GA
Clarksville-Hopkinsville	TN-KY
Johnson City-Kingsport-Bristol	TN-VA
Abilene	TX
Amarillo	TX
Austin	TX
Beaumont-Port Arthur	TX
Brownsville-Harlingen-San Benito	TX
Bryan-College Station	TX
Corpus Christi	TX
Dallas-Fort Worth-Arlington	TX

Athens	GA		El Paso	TX
Atlanta	GA		Houston-Galveston-Brazoria	TX
Columbus	GA		Killeen-Temple	TX
Macon	GA		Laredo	TX
Savannah	GA		Long View-Marshall	TX
Augusta-Aiken	GA-SC		Lubbock	TX
Evansville-Henderson	IN-KY		McAllen-Edinburg-Mission	TX
Lexington	KY		Odessa-Midland	TX
Owensboro	KY		San Angelo	TX
Louisville	KY-IN		San Antonio	TX
Alexandria	LA		Sherman-Denison	TX
Baton Rouge	LA		Tyler	TX
Houma	LA		Victoria	TX
Lafayette	LA		Waco	TX
Lake Charles	LA		Wichita Falls	TX
Monroe	LA		Charlottesville	VA
New Orleans	LA		Danville	VA
Shreveport-Bossier City	LA		Lynchburg	VA
Biloxi-Gulfport-Pascagoula	MS		Richmond-Petersburg	VA
Hattiesburg	MS		Roanoke	VA
Jackson	MS		Norfolk-Virginia Beach-Newport News	VA-NC
Asheville	NC		Huntington-Ashland	WY-KY-OH

Appendix 3: Index of All MSAs

MSA	State	Rank
Austin	TX	1
Charlottesville	VA	2
Lexington	KY	3
Raleigh-Durham-Chapel Hill	NC	4
Atlanta	GA	5
Huntsville	AL	6
Gainesville	FL	7
Tallahassee	FL	8
Charlotte-Gastonia-Rock Hill	NC-SC	9
Richmond-Petersburg	VA	10
Fort Walton Beach	FL	11
Columbia	SC	12
Naples	FL	13
Dallas-Fort Worth-Arlington	TX	14
Jackson	MS	15
Norfolk-Virginia Beach-Newport News	VA-NC	16
Orlando	FL	17
Melbourne-Titusville-Palm Bay	FL	18
Asheville	NC	19
Sarasota-Bradenton	FL	20
Auburn-Opelika	AL	21
Charleston-North Charleston	SC	22
Houston-Galveston-Brazoria	TX	23
Wilmington	NC	24
Cincinnati-Hamilton	OH-KY-IN	25
Greenville	NC	26
Oklahoma City	OK	27
Savannah	GA	28
Little Rock-North Little Rock	AR	29
Jacksonville	FL	30
Columbus	GA	58
Greensboro-Winston-Salem-High Point	NC	59
Panama City	FL	60
Lafayette	LA	61
Baton Rouge	LA	62
Daytona Beach	FL	63
Amarillo	TX	64
Johnson City-Kingsport-Bristol	TN-VA	65
Lawton	OK	66
Shreveport-Bossier City	LA	67
Chattanooga	TN-GA	68
Clarksville-Hopkinsville	TN-KY	69
Evansville-Henderson	IN-KY	70
Macon	GA	71
Wichita Falls	TX	72
Fayetteville-Springdale-Rogers	AR	73
Abilene	TX	74
Florence	SC	75
Monroe	LA	76
Albany	GA	77
Anniston	AL	78
Lynchburg	VA	79
Lake Charles	LA	80
Mobile	AL	81
Corpus Christi	TX	82
Sumter	SC	83
Sherman-Denison	TX	84
Biloxi-Gulfport-Pascagoula	MS	85
Jacksonville	NC	86
Owensboro	KY	87

Nashville	TN	31
Knoxville	TN	32
Fort Myers-Cape Coral	FL	33
Tampa-St. Petersburg-Clearwater	FL	34
Birmingham	AL	35
Hattiesburg	MS	36
Lubbock	TX	37
Tuscaloosa	AL	38
Greenville-Spartanburg-Anderson	SC	39
Tyler	TX	40
Louisville	KY-IN	41
Montgomery	AL	42
Pensacola	FL	43
San Antonio	TX	44
Tulsa	OK	45
Athens	GA	46
San Angelo	TX	47
New Orleans	LA	48
Memphis	TN-AR-MS	49
Fayetteville	NC	50
Roanoke	VA	51
Fort Pierce-Port St. Lucie	FL	52
Punta Gorda	FL	53
Augusta-Aiken	GA-SC	54
Killeen-Temple	TX	55
Myrtle Beach	SC	56
Jackson	TN	57
El Paso	TX	88
Florence	AL	89
Texarkana-TX-Tesarkana	AR	90
Long View-Marshall	TX	91
Alexandria	LA	92
Jonesboro	AR	93
Huntington-Ashland	WY-KY-OH	94
Lakeland-Winter Haven	FL	95
Gadsden	AL	96
Ocala	FL	97
Hickory-Morganton-Lenoir	NC	98
Goldsboro	NC	99
Decatur	AL	100
Beaumont-Port Arthur	TX	101
Dothan	AL	102
Victoria	TX	103
Bryan-College Station	TX	104
Fort Smith	AR-OK	105
Pine Bluff	AR	106
Rocky Mount	NC	107
Danville	VA	108
Brownsville-Harlingen-San Benito	TX	109
McAllen-Edinburg-Mission	TX	110
Odessa-Midland	TX	111
Laredo	TX	112
Houma	LA	113
Waco	TX	114

Appendix 4: Index of MSAs in Neighboring States

MSA	State	Rank
Raleigh-Durham-Chapel Hill	NC	1
Huntsville	AL	2
Atlanta	GA	3
Charlotte-Gastonia-Rock Hill	NC-SC	4
Columbia	SC	5
Auburn-Opelika	AL	6
Asheville	NC	7
Charleston-North Charleston	SC	8
Wilmington	NC	9
Greenville	NC	10
Savannah	GA	11
Nashville	TN	12
Knoxville	TN	13
Athens	GA	14
Birmingham	AL	15
Tuscaloosa	AL	16
Greenville-Spartanburg-Anderson	SC	17
Montgomery	AL	18
Memphis	TN-AR-MS	19
Fayetteville	NC	20
Augusta-Aiken	GA-SC	21
Myrtle Beach	SC	22
Greensboro-Winston-Salem-High Point	NC	23
Jackson	TN	24
Columbus	GA	25
Johnson City-Kingsport-Bristol	TN-VA	26
Clarksville-Hopkinsville	TN-KY	27
Chattanooga	TN-GA	28
Macon	GA	29
Florence	AL	30
Albany	GA	31
Anniston	AL	32
Mobile	AL	33
Sumter	SC	34
Jacksonville	NC	35

Florence	SC	36
Gadsden	AL	37
Hickory-Morganton-Lenoir	NC	38
Goldsboro	NC	39
Decatur	AL	40
Dothan	AL	41
Rocky Mount	NC	42

Appendix 5a: Ranks Compared to Milken's Best Performing Cities- Large

MSA	State	Milken	Index
Austin	TX	4	1
Huntsville	AL	5	5
Wilmington	NC	6	23
McAllen-Edinburg-Mission	TX	7	110
Charleston-North Charleston	SC	10	22
Orlando	FL	11	18
Killeen-Temple	TX	13	55
Lafayette	LA	14	61
San Antonio	TX	15	45
Houston-Galveston-Brazoria	TX	16	26
Myrtle Beach	SC	19	56
Raleigh-Durham-Chapel Hill	NC	21	4
Nashville	TN	22	30
Dallas-Fort Worth-Arlington	TX	23	14
Savannah	GA	24	29
Charlotte-Gastonia-Rock Hill	NC-SC	26	9
Ocala	FL	30	98
Pensacola	FL	33	44
Gainesville	FL	34	7
Columbia	SC	36	12
El Paso	TX	37	89
Montgomery	AL	38	42
Jacksonville	FL	39	31
Baton Rouge	LA	40	60
Asheville	NC	46	20
Amarillo	TX	49	65
Oklahoma City	OK	50	28
Clarksville-Hopkinsville	TN-KY	51	68
Fayetteville	NC	52	50
Little Rock-North Little Rock	AR	54	27
Lubbock	TX	56	34
Fayetteville-Springdale-Rogers	AR	57	72
Atlanta	GA	59	6
Knoxville	TN	60	32
Shreveport-Bossier City	LA	67	67
Greenville-Spartanburg-Anderson	SC	68	40

Fort Smith	AR-OK	69	105
Beaumont-Port Arthur	TX	70	102
Lynchburg	VA	71	79
Tulsa	OK	72	46
Fort Pierce-Port St. Lucie	FL	78	52
Tampa-St. Petersburg-Clearwater	FL	80	38
Naples	FL	83	13
Corpus Christi	TX	88	82
Mobile	AL	91	81
Daytona Beach	FL	92	63
Lakeland-Winter Haven	FL	98	96
Greensboro-Winston-Salem-High Point	NC	99	57
Richmond-Petersburg	VA	102	10
Chattanooga	TN-GA	110	69
Tallahassee	FL	115	8
Brownsville-Harlingen-San Benito	TX	119	109
Fort Myers-Cape Coral	FL	120	35
Augusta-Aiken	GA-SC	121	53
Lexington	KY	122	3
Johnson City-Kingsport-Bristol	TN-VA	128	64
Louisville	KY-IN	131	43
Evansville-Henderson	IN-KY	142	70
Memphis	TN-AR-MS	144	48
Birmingham	AL	150	37
New Orleans	LA	151	47
Huntington-Ashland	WY-KY-OH	153	95
Jackson	MS	154	16
Columbus	GA	166	59
Roanoke	VA	168	51
Cincinnati-Hamilton	OH-KY-IN	173	25
Hickory-Morganton-Lenoir	NC	191	99
Melbourne-Titusville-Palm Bay	FL	104	19
Norfolk-Virginia Beach-Newport News	VA-NC	89	17
Sarasota-Bradenton	FL	97	21

Appendix 5b: Ranks Compared to Milken's Best Performing Cities- Small

MSA	State	Milken	Index
Charlottesville	VA	18	2
Auburn-Opelika	AL	19	15
Greenville	NC	22	24
Tyler	TX	26	41
Waco	TX	27	114
Panama City	FL	30	62
Hattiesburg	MS	31	33
Fort Walton Beach	FL	32	11
Anniston	AL	34	78
Athens	GA	37	36
Bryan-College Station	TX	38	94
Abilene	TX	40	74
Tuscaloosa	AL	42	39
Laredo	TX	44	112
Florence	SC	51	88
Wichita Falls	TX	61	73
Dothan	AL	70	103
Lake Charles	LA	74	80
Florence	AL	76	75
Alexandria	LA	78	92
Decatur	AL	79	101
Texarkana-TX-Tesarkana	AR	81	90
Jackson	TN	85	58
Rocky Mount	NC	93	107
Albany	GA	98	77
Macon	GA	102	71
Monroe	LA	109	76

Appendix 6: Ranks Compared to Florida's Creativity Index

MSA	State	Creativity	Index
Melbourne-Titusville-Palm Bay	FL	29	19
Gainesville	FL	34	7
Huntsville	AL	40	5
Little Rock-North Little Rock	AR	53	27
Sherman-Denison	TX	58	84
Birmingham	AL	60	37
Tulsa	OK	61	46
Columbia	SC	62	12
Lexington	KY	63	3
Richmond-Petersburg	VA	66	10
Baton Rouge	LA	72	60
Jackson	MS	75	16
Asheville	NC	78	20
Wilmington	NC	79	23
Tallahassee	FL	80	8
Charleston-North Charleston	SC	85	22
Knoxville	TN	89	32
Charlottesville	VA	96	2
Bryan-College Station	TX	99	94
Pensacola	FL	102	44
Sarasota-Bradenton	FL	107	21
Fort Myers-Cape Coral	FL	108	35
Mobile	AL	109	81
Greenville-Spartanburg-Anderson	SC	110	40
Long View-Marshall	TX	115	91
Corpus Christi	TX	116	82
Montgomery	AL	120	42
Greenville	NC	122	24
Athens	GA	124	36
Albany	GA	127	77
Roanoke	VA	128	51
Brownsville-Harlingen-San Benito	TX	135	109
Fort Pierce-Port St. Lucie	FL	136	52
Chattanooga	TN-GA	139	69
Daytona Beach	FL	142	63
Amarillo	TX	143	65

Fort Walton Beach	FL	146	11
Johnson City-Kingsport-Bristol	TN-VA	148	64
Augusta-Aiken	GA-SC	151	53
Monroe	LA	151	76
Evansville-Henderson	IN-KY	154	70
Tyler	TX	155	41
El Paso	TX	156	89
Macon	GA	159	71
Savannah	GA	161	29
Lubbock	TX	163	34
McAllen-Edinburg-Mission	TX	164	110
Lynchburg	VA	169	79
Naples	FL	170	13
Abilene	TX	173	74
Lafayette	LA	175	61
San Angelo	TX	179	49
Biloxi-Gulfport-Pascagoula	MS	186	85
Huntington-Ashland	WY-KY-OH	187	95
Columbus	GA	192	59
Hickory-Morganton-Lenoir	NC	193	99
Dothan	AL	193	103
Rocky Mount	NC	195	107
Lakeland-Winter Haven	FL	196	96
Beaumont-Port Arthur	TX	198	102
Fayetteville-Springdale-Rogers	AR	200	72
Panama City	FL	203	62
Florence	SC	204	88
Myrtle Beach	SC	205	56
Decatur	AL	207	101
Punta Gorda	FL	209	54
Houma	LA	211	113
Waco	TX	212	114
Alexandria	LA	214	92
Jackson	TN	215	58
Lake Charles	LA	219	80
Fayetteville	NC	220	50
Goldsboro	NC	221	100
Killeen-Temple	TX	223	55

Sumter	SC	226	83
Fort Smith	AR-OK	231	105
Odessa-Midland	TX	234	111
Laredo	TX	235	112
Anniston	AL	236	78
Ocala	FL	237	98
Tuscaloosa	AL	238	39
Florence	AL	241	75
Texarkana-TX-Tesarkana	AR	245	90
Shreveport-Bossier City	LA	247	67
Wichita Falls	TX	249	73
Gadsden	AL	253	97
Pine Bluff	AR	260	106
Clarksville-Hopkinsville	TN-KY	261	68
Danville	VA	262	108
Victoria	TX	263	104
Lawton	OK	264	66
Jacksonville	NC	265	86
Owensboro	KY	266	87

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