6-2008

BUILDING A KNOWLEDGE ECONOMY INDEX FOR THE FIFTY STATES WITH A FOCUS ON SOUTH CAROLINA: THE CLEMSON KNOWLEDGE ECONOMY INDEX

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A Thesis
Presented to
the Graduate School of
Clemson University

In Partial Fulfillment
of the Requirements for the Degree
Master of Arts
Economics

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by
Tate Martin Watkins
August 2008

Accepted by:
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ABSTRACT

This paper seeks to express the relevance of the knowledge economy to economic growth and development and to demonstrate the construction of a knowledge economy index for the fifty states, with a focus on South Carolina. The effort involves a survey of economic literature, reports and indexes related to the knowledge economy. Once significant knowledge economy indicators are identified, regression analysis is performed to select the most promising indicators for use as variables in the index. Statistical testing is also used to determine weights for index components. The thesis project was supported by the South Carolina Research Authority, an organization charged with developing South Carolina's knowledge economy. The Clemson Knowledge Economy Index that resulted from this thesis research specifically assesses the performance of South Carolina's emerging knowledge economy relative to other states and the nation. The index can be readily constructed for other states and for any state in future years.

ACKNOWLEDGEMENTS

I am extremely thankful for everyone who helped make this thesis possible.

First of all, I would like to thank the South Carolina Research Authority for sponsoring the project and offering guidance along the way. I hope that the final product of my efforts has provided a useful and effective tool to help advance their policy goals and overall success.

I also wish to thank the many people who offered advice and guidance throughout the project, including those who made time to meet with me on visits to Washington DC and Dallas. I would specifically like to thank Dan Correa of the Information Technology and Innovation Foundation for his willingness to meet with me on two occasions, answer questions, share ideas and data and offer feedback on my work.

I am also grateful for the support of the entire Clemson economics department, specifically my committee members, Skip Sauer and John Warner, and also my professor and graduate school coordinator, Mike Maloney.

Most importantly, I would like to express my immense gratitude and thankfulness to Bruce Yandle, my thesis advisor. Having the pleasure and opportunity to work with him this past year has been incredible and has affected my life and future indelibly, for which I cannot thank him enough. It is an honor to call him a colleague, but more importantly to me, I am grateful to call him a friend.

Lastly, I would like to thank my parents, William and Barbara Watkins for always supporting me in every endeavor, and I am specifically grateful for my mother, an English teacher, agreeing to suffer through proof-reading an economics thesis.

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Chapter One

INTRODUCTION

Since Adam Smith, economists have focused much research on growth and development driven by human capital. Smith's magnum opus sought to explain differences in standards of living between nations, and it may be remembered that his work was entitled *An Inquiry into the Nature and Causes of the Wealth of Nations* (1784). This paper seeks to explain differences in standards of living between the fifty American states. Such a study is clearly at the center of economic inquiry. It should be noted that the nations Smith considered were smaller than the American states of today.

Economists have studied human capital driven economic development since the conception of economics, but only in modern times have they assessed and sought quantitatively to measure the economic return to human capital. One such example is Gary Becker's analysis of human capital investment, specifically education, in *Human Capital* (1994). A more recent example is the effort by Baier, Dwyer and Tamura (2006) to explain productivities of labor and capital with total factor productivity models. Perhaps the most recent attempt by economists to measure the return on human capital is found in efforts to measure the knowledge economy. For example, the World Bank (2007) rates countries based on their abilities to produce and diffuse knowledge. The Milken Institute's Knowledge-based Economy Index (2001) ranks states based on how well they are equipped to advance knowledge and promote high tech growth. Specific to South Carolina, Barkley and Henry (2005) incorporate the use of several human capital indicators in their assessment of the competitiveness of South Carolina's cities. The state knowledge economy index I develop in this paper seeks to explain economic growth and development through the lens of human capital innovation.

Thomas Green Clemson and the Knowledge Economy

A goal of this paper is to describe the process of building an index that can be periodically reproduced in the future and is capable of registering evidence of progress of building and maintaining a prosperous knowledge economy in South Carolina. Such an economy is driven by innovative human capital, which is also the source of the economy's competitiveness. Interestingly, when willing his estate to the state South Carolina (1888), Thomas Green Clemson asserted:

> …there can be no permanent improvement in agriculture without a knowledge of those sciences which pertain particularly thereto…the benefits herein sought to be bestowed are intended to benefit agricultural and mechanical industries. I trust that I do not exaggerate the importance of such an institution for developing the material resources of the State…

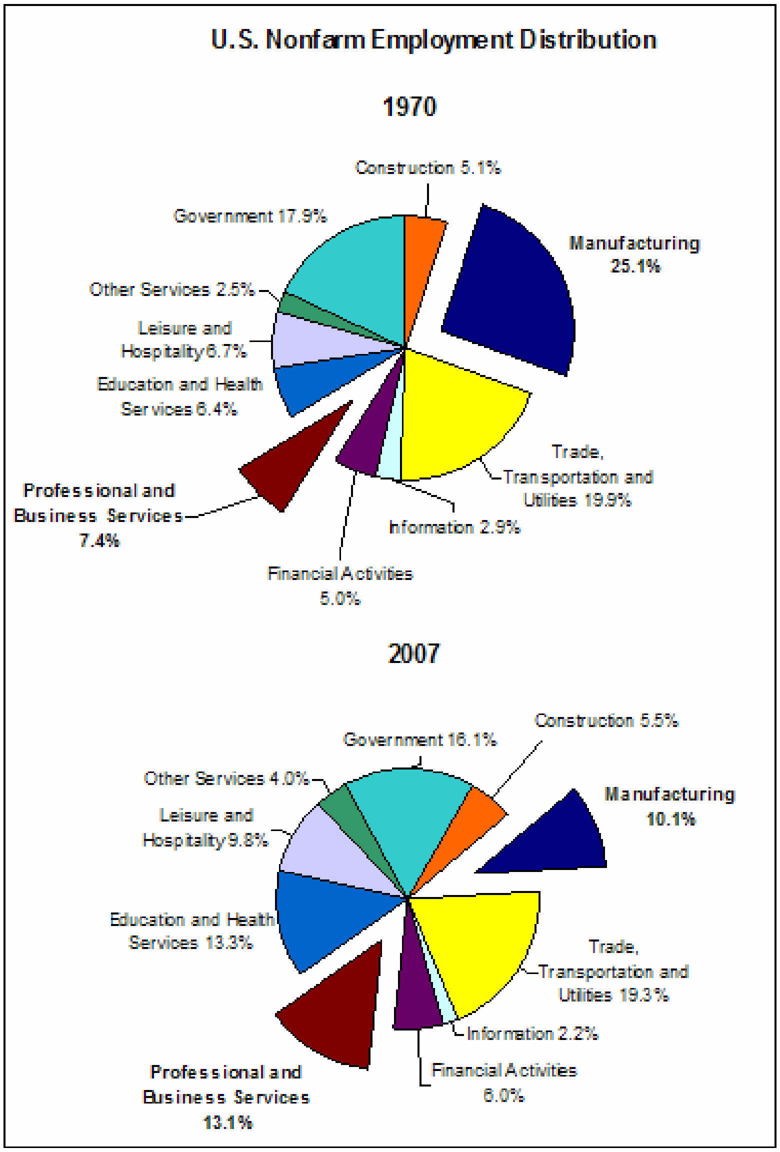
Thomas Green Clemson essentially wished to create an opportunity for farmers and mechanics of the state to increase and enhance their knowledge bases; Clemson Agricultural College of South Carolina was an investment in the state's innovative human capital and an effort to develop the material resources of the state. My Clemson Knowledge Economy Index evaluates the progress of developing and advancing a prosperous South Carolina knowledge economy that is cultivated by the state's innovative human capital and adds value to the state.

In a knowledge economy, value lies increasingly in ideas, services, information, technological innovation and relationships. A knowledge economy is characterized by the recognition of knowledge as the source of its competitiveness, the increasing importance of scientific research and development and innovation in knowledge creation, and the use of technology to generate, share and apply knowledge. For the advanced world economies of today, the amount and connectivity of human knowledge is perhaps the most significant determinant of standard of living, and these economies are definitely driven by technological advances and human capital (Yandle 2007).

This paper also describes an attempt to quantify the competitive struggle among states to enhance economic growth and development in an evolving national economy. In 1970, the manufacturing sector employed one quarter of the nation's workforce[1] and dominated American industry, and high tech, high knowledge sectors composed a rather small portion of overall industry activity. By 1999, high tech, telecommunications and heath care industries accounted for 53 percent of the market value of businesses, and the value of U.S. manufacturing companies had fallen drastically (Cox 1999). The Bureau of Labor Statistics classifies the knowledge-based, human capital driven sector of the economy as professional and business services. Figure 1 graphically demonstrates the gradual shift in the U.S. from an economy dominated by manufacturing to one based on knowledge.

[1] Bureau of Labor Statistics (2008)

Figure 1: Percent Distribution of U.S. Nonfarm Employment by Industry[2]



Undeveloped societies are generally centered on agricultural production. Technological advancement leads to industrialization, which then gives way to the emergence and development of the manufacturing sector. Today, the new economic transition is from manufacturing and industry to economies founded on knowledge and

[2] Bureau of Labor Statistics (2008)

technology based sectors. An examination of the evolution of economic development through history demonstrates important shifts in the most valued worker skill sets of economies at different levels of development. Physical strength and power are important to developing economies that possess low levels of technology. Industrialization and the rise of manufacturing causes manual dexterity to be valued highly as the demand for highly skilled factory workers increases exponentially. In the new knowledge economy, however, highly valued skills include analytical reasoning, imaginative creativity, people skills and emotional intelligence (Cox 2003). Such innovative human capital drives the emerging knowledge economy.

Organization of the Thesis

The Clemson Knowledge Economy Index measures economic progress of states by taking into account multiple indicators, or drivers, of a knowledge economy. In explaining how the index is built, Chapter Two describes my review of knowledge and related indexes and reports. This survey allowed me to identify and justify the best practices for constructing the Clemson Knowledge Economy Index. Chapter Three describes the development and testing of regression models that led me to construct the final index model. In that chapter, I produce the 2007 Clemson Knowledge Economy Index and demonstrate its effectiveness at measuring knowledge economy progress. I also provide evidence of the ability of the index to function effectively over a meaningful time period. Finally, Chapter Four concludes the thesis with final thoughts on the research and a presentation of mapped results for the fifty states.

Chapter Two

SURVEYING THE KNOWLEDGE ECONOMY

Review of other Indexes and Reports

In an effort to identify effective index building techniques and to discover what specifically drives a successful knowledge economy, I surveyed literature associated with building indexes and reviewed a number of reports specifically related to the knowledge economy. The Fraser Institute (2007) and The Heritage Foundation (2008) both publish indexes that rate countries based on economic freedom by considering aspects such as property rights, political institutions and trade freedoms. Numerous state indexes also seek to measure such aspects as competitiveness, entrepreneurship, government effectiveness and components of the so-called new economy. Examples are the ALEC-Laffer State Economic Competitiveness Index (2008), the Kauffman Index of Entrepreneurial Activity State Report (2005), the U.S. Economic Freedom Index (2004) and the 2007 State New Economy Index (2007).

The World Bank Knowledge Index and Knowledge Economy Index attempt to measure countries' effectiveness of producing and utilizing knowledge, respectively. The Knowledge Economy Index specifically considers the ability of countries to economically realize their knowledge and human capital. The Milken Institute (2001) publishes a wide variety of indexes, one of which rates states based on the performance of knowledge and high tech growth indicators. These indexes are directly applicable to this project because they specifically measure the knowledge economy.

Other reports that seek to measure or assess economic growth and development driven at least partially by the knowledge economy include the Boston Indicators Project (2007), Dynamics of Technology Based Economic Development (2004), the Innovation-Entrepreneurship NEXUS (2005) and Grading the States 2008 (2008).

Reports that focus on South Carolina or pertain to the state specifically are Barkley and Henry's "Innovative Metropolitan Areas in the South: How Competitive are South Carolina's Cities?" (2005), the South Carolina Competitiveness Initiative (2003) published by New Carolina, and the Greater Greenville Regional Economic Scorecard (2008).

All of these studies acknowledge that a strong knowledge base is critically important to building a successful and effective knowledge economy. My research, to be examined in further detail later in this paper, suggests that education, specifically bachelor's and post-graduate degrees, is the single most significant driver of the knowledge economy; however, a community or state with a sophisticated knowledge base must be well-connected and able to commercialize its knowledge in order for it to be productive. Successful knowledge economies are able to market intellectual capital by also utilizing highly developed social skills, communication abilities and emotional intelligence (Cox 2003), aspects that all contribute to entrepreneurial activity. In addition to generating new knowledge, a successful knowledge economy has features that bridge the gap between innovation and commercialization, a bridge generally referred to as entrepreneurship (Camp 2005). A knowledge economy successfully links knowledge-based human capital and innovative activity with commercial entrepreneurship. The essential components of the knowledge economy, therefore, are knowledge, innovation and entrepreneurship.

Selecting and Weighting Index Components

Virtually all the indexes I researched use box score methodology. This approach often uses a sizable number of indicator variables that are subsumed into an index. Generally speaking, the indicator variables used in these types of indexes are simply weighted equally or weights are assigned conceptually based on theoretical conjecture. One criticism of this approach is that when numerous highly correlated variables are included in an index, their effect on the final index score is inflated because of multiple counting. As noted in *Grading Places* (2005), a study in methodology of economic indexes and rankings, equally weighted variables are often inaccurate representations of the relative effects of indicator variables. In addition, indexes composed of a multitude of indicators can be cumbersome because they are typically complex and complicated to build, and weights that are assigned conceptually can be somewhat subjective or have little statistical integrity.

The index developed in this report takes a different approach. As will be explained in the next chapter, I develop regression models for assigning weights to the variables that were ultimately selected for my state knowledge economy index. By using statistical analysis to assign weights to the indicator variables, the effect of each variable on the final index result is accurately measured. Criticism of this approach is that statistically weighting each independent variable simply scales the dependent variable. I addressed this concern when developing my index and discuss the issue in the statistical chapter of this paper.

I also sought to use as few variables as necessary to ensure that the index is as uncomplicated as possible. The principle of Occam's razor[3] asserts that the simplest valid explanation is most useful. The Clemson Knowledge Economy Index includes three

[3] Stanford Encyclopedia of Philosophy (2006)

indicator variables yet still accurately and thoroughly measures the effectiveness of state knowledge economies.

As indicated, the first step of the project involved assessing recently published knowledge economy indexes and related reports. This survey provided valuable insight into my construction of a state knowledge economy index and led me to conclude that the 2007 State New Economy Index (2007) was the most promising and relevant report for my project. My efforts to evaluate and deconstruct this index and its variables greatly assisted my development of the Clemson Knowledge Economy Index, which is described in detail in the following chapter.

Chapter Three

REPORTING ESTIMATES AND BUILDING THE INDEX

This chapter reports on the empirical work undertaken to develop a 2007 state knowledge economy index for South Carolina and each of the other American states. Having such an index enables one to observe and assess the relative effectiveness of any state's knowledge economy. The chapter details the statistical journey I took to develop a final index. In the first part of the chapter, I describe the various indicators that were examined as possible variables to use in an index. Then, I describe the regression models that were initially developed and explain the steps taken to select the final knowledge economy regression model. I then describe the data that was used to estimate the 2007 Clemson Knowledge Economy Index.

Since several statistical models were developed in my research, I report estimates for key models and then explain how the regression coefficients were used to build a final state index. In an effort to assess the model's performance, I test the model against data for an earlier period and report the results for a 2000 Clemson Knowledge Economy Index. I also diagnose the model and compare the index results across states and time, and against other indexes. Finally, I provide some thoughts and advice for future state knowledge economy index researchers.

Indicators

My survey of economic literature on the knowledge economy and my search of knowledge economy indexes led me to identify the 2007 State New Economy Index (2007 SNEI) as an extremely relevant reference for my project. Based on 26 indicators, this index contains the seeds for building a robust knowledge economy index for the states. The 2007 SNEI ranks states based on the structures of their economies and essentially asserts how effectively states are transforming from old-fashioned, manufacturing centered economies into new knowledge economies fueled by high value-added and high wage jobs. I selected the data set from the 2007 SNEI to create initial models of state knowledge economies.

The ultimate goal of a successful knowledge economy is to increase the welfare of society. I tested two dependent variables as measures of welfare: per capita income and per capita gross domestic product (GDP). Preliminary statistical results showed that state per capita income is a better measure of the effectiveness of a knowledge economy than per capita GDP. South Carolina policy makers generally attest that increasing state per capita income is the fundamental goal of all economic development efforts. An examination of national economic data on the knowledge economy tells us that those states with larger knowledge economy sectors also generally have higher per capita incomes.[4] A viable knowledge economy index must, therefore, have components that pass a per capita income test.

Additionally, two measures were tested as control variables: median age and mean temperature. Economic logic for including median age as a control is based on the positive correlation between age and increased skill level, productivity and work experience, which all raise per capita income and GDP. Mean temperature was included because, generally speaking, income and GDP per capita are higher in temperate zones.

[4] According to the Bureau of Labor Statistics, the sector of the economy with knowledge workers is professional and business services. A mapping of this sector to per capita income shows a close relationship. This mapping is found in Table 2 of the Appendix. Table 3 of the Appendix shows state rankings by various knowledge economy indexes, including the Clemson Knowledge Economy Index, and state rankings by per capita income and per capita GDP.

Drawing from the 2007 SNEI data set, I developed several conceptual models that explain variation in per capita income and across the fifty states. Because the index developed in this project must be replicated for years to come, data used in the index ideally can be gathered at low cost. Data must be available at no less than annual frequency and must be from reliable and credible published sources. In accordance with Occam's razor and in order for the replication process to be as simple and straightforward as possible, I sought to include the least number of variables required to measure the effectiveness of the knowledge economy. I therefore decided that only variables that can be replicated relatively easily and inexpensively would be considered for the state knowledge economy index model, and as few indicator variables as necessary would be used.

The 26 indicators that compose the 2007 SNEI are grouped into five categories: knowledge jobs, globalization, economic dynamism, digital economy and innovation capacity. From this set of indicators, I selected variables that seem a priori to drive the knowledge economy, that make sense in terms of economic logic and that are of interest to practitioners in the field of economic development. On that basis, the following variables were examined as candidates for the index. Descriptive statistics for the dependent, control and candidate variables are found in Table 1 below.[5]

- Fast Growth Firms – Number of Deloitte Technology Fast 500 and Inc. 500 firms as a share of total firms

- Gazelle Jobs – Jobs in gazelle companies (firms with annual sales revenues that have grown 20 percent or more for four straight years) as a share of total employment

[5] Descriptions of variables come from the 2007 State New Economy Index (2007). A more complete description of variables with sources is included in the Appendix.

- High Tech Jobs – Jobs in electronics manufacturing, software and computer related services, telecommunications, and biomedical industries as a share of total employment

- Industry Research and Development – Industry-performed research and development as a percentage of total worker earnings, controlling for the overall industrial mix in each state

- Job Churning – The number of new start-ups and business failures, combined, as a share of the total firms in each state

- Managerial, Professional and Technical Jobs – Managers, professionals and technicians as a share of the total workforce

- Patents – Number of patents issued to companies or individuals per 1,000 workers, controlling for the overall industrial mix in each state

- Scientists and Engineers – Scientists and engineers as a percentage of the workforce

- Venture Capital – Venture capital invested as a share of worker earnings

- Workforce Education – Weighted measure of educational attainment (advanced degrees, bachelor's degrees, associate's degrees or some college coursework) of the workforce

Table 1: Descriptive Statistics for Variables

	Mean	Std. Dev.	Min	Max
Dependent Variables				
Per Capita Income	$24,543	3,479	18,165	34,048
Per Capita GDP	$35,460	6,303	23,498	58,214
Control Variables				
Median Age	36.9	2.1	28.4	41.0
Mean Temperature	52.1	7.6	40.4	70.7
Candidate Variables				
Fast Growth Firms	0.00019	0.00018	0.00000	0.00082
Gazelle Jobs	0.072	0.028	0.031	0.166
High-tech Jobs	0.033	0.013	0.014	0.065
Industry R&D	0.023	0.015	0.004	0.071
Job Churning	0.252	0.044	0.153	0.381
Managerial, Prof, Tech Jobs	0.204	0.022	0.150	0.268
Patents	0.619	0.470	0.120	2.990
Scientists and Engineers	0.004	0.002	0.002	1.000
Venture Capital	0.023	0.015	0.004	0.071
Workforce Education	0.390	0.060	0.261	0.524

Some of the candidate variables are highly collinear and ideally should not be included in the same regression model. A correlation matrix for the candidate variables can be found in Table 1 of the Appendix. To avoid a collinearity problem, I used statistical testing to select a single variable as a proxy of each component of the knowledge economy – knowledge, innovation, and entrepreneurship.

The candidate variables come from the 2007 SNEI data set, but I drew from other sources to narrow the list of candidates. The Federal Reserve Bank of Dallas 2006 Annual Report "The Best of All Worlds" (2006) lists several world knowledge indicators, including the share of the world's population with bachelor's and advanced degrees, research and development spending, science and engineering doctorates and patent applications. In addition, Barkley and Henry (2005) use similar education and innovation indicators in their paper, and they also utilize measures to assess entrepreneurship environment, including an

Inc. 500 list measure. The Milken Institute Knowledge-based Economy Index (2001) also includes indicators for bachelor's and graduate degrees, venture capital, industry research and development, patents, and science and engineering doctorates. My examination of related literature and indexes confirms that these variables are all significant drivers of the knowledge economy.

Preliminary Statistical Models

One of the early conceptual statistical models focused on research and development and entrepreneurship, while another focused on education variables. Per capita income was the dependent variable in each model. Based on discussions with professionals in the state economic development arena, both models satisfied the policy goal of measuring activities that might be affected by economic development policies.

The research and development model utilized four indicators: industry research and development, fast growth firms, venture capital and patents and included two control variables.

The model is written:

PCI = F(R&D, FGF, VC, PATENTS, MEDAGE, MEANTEMP)

The industry research and development variable is the amount of private expenditures on R&D weighted by the total worker earnings of that state, controlling for the overall industrial mix in each state. Fast growth firms are the percentage of firms in a state that are designated on the Inc. 500 and Deloitte Technology Fast 500 lists. Venture capital is measured by investment dollars per state and is weighted by worker earnings. The patents measure is the number of patents per state for each 1,000 workers and also controls for the overall industrial mix in each state. These indicators comprise the research and development model. An ordinary least squares regression was run using this model; the results are shown in Table 2 below.

Table 2: Regression Results of R&D Model on Per Capita Income

Regressor	Coefficient	Robust Std. Err.	t
Industry R&D	94662.86	39366.26	2.40**
Fast Growth Firms	1.04e+07	2832454	3.68**
Venture Capital	341668.9	146273.3	2.34**
Patents	-468.6623	1206.174	-0.39
Median Age	690.5018	307.328	2.25**
Mean Temp	-109.1396	68.63797	-1.59
Constant	8989.718	13194.76	0.68
Summary Statistics			
SER	3568.2		
R^2	0.5329		
F-statistic	10.59		
n	48		
**5% significance level			
*10% significance level			

The fast growth firms, industry R&D and venture capital variables were all positive and statistically significant at the five percent level. Median age was also significant at the five percent level as a control variable, while patents and mean temperature were not significant.

The second model included workforce education, managerial, professional and technical jobs, scientists and engineers and two control variables and is written as follows:

PCI = F(EDU, MPTJOBS, SCI&ENG, MEDAGE, MEANTEMP)

Workforce education is a weighted measure of the undergraduate and graduate educational attainment of each state's workforce. The management, professional and technological jobs indicator is the proportion of such jobs in a state's economy as defined by the Bureau of

Labor and Statistics, and the scientists and engineers variable is a measure of the percentage of such workers in a state's workforce. Results from the second model are below in Table 3.

Table 3: Regression Results of Education Model on Per Capita Income

Regressor	Coefficient	Robust Std. Err.	t
Workforce Education	46077.98	6471.962	7.12**
MPT Jobs	29390.03	29670.55	0.99
Scientists/Engineers	-219191	231764.5	- 0.95
Median Age	334.4816	134.6528	2.48**
Mean Temp	50.25935	27.99287	1.80*
Constant	-13587.6	8313.894	1.63
Summary Statistics			
SER	1813.6		
R^2	0.7616		
F-statistic	27.68		
n	48		
**5% significance level			
*10% significance level			

Workforce education was significant at the five percent level in the second model, a logical and appealing result for a knowledge economy index. The median age control remained significant; however, none of the other independent variables were statistically significant.

The last preliminary model combined the most statistically significant indicators of the previous two models, which were industry R&D, venture capital, workforce education and fast-growth firms. Both control variables were also included in this model.

PCI = F(R&D, VC, EDU, FGF, MEDAGE, MEANTEMP)

The regression results from this combined model indicate several indicators that are strong candidates to include in the Clemson Knowledge Economy Index. Those results are found in Table 4.

Table 4: Regression Results of Combined Model on Per Capita Income

Regressor	Coefficient	Robust Std. Err.	t
Industry R&D	41076.88	17023.01	2.41**
Venture Capital	-56653.44	114249.5	-0.50
Workforce Education	35079.34	8557.812	4.10**
Fast Growth Firms	5369106	1791671	3.00**
Median Age	451.4276	130.6282	3.46**
Mean Temp	19.63058	40.71344	0.48
Constant	-8878.36	7887.994	-1.1
Summary Statistics			
SER	1672.8		
R^2	0.8021		
F-statistic	26.60		
n	48		

**5% significance level
*10% significance level

Examination of the regression analysis shows that the most effective knowledge economy measures proved to be workforce education, industry R&D and fast-growth firms. Recall that my research led me conceptually to define a knowledge economy to be composed of three elements: knowledge, innovation and entrepreneurship. A successful knowledge economy index, therefore, captures the effect of each component on the economy.

The workforce education variable is statistically an extremely important determinant of per capita income, and, therefore, explains much of the effectiveness of a knowledge economy.[6] This indicator signals the amount of knowledge or human capital a state possesses, which is theoretically relevant to explaining the performance of a state's knowledge economy.

[6] In statistical testing of the decomposed workforce education variable, bachelor's, master's and professional degrees were the most significant drivers of per capita income, implying that these types of degrees are the most important educational drivers of the knowledge economy.

Industry research and development expenditures, weighted by worker earnings, explain the innovation component of the knowledge economy. Other indicators, such as patents and venture capital, were tested in an attempt to measure this component, but industry R&D was most significant statistically. Additionally, most of these measures are highly correlated, so it is superfluous to include all of them in the final model. Academic research and development was also tested as a proxy for innovation, but much academic research is funded for the sake of producing scientists and doctorate degrees, not necessarily in an attempt to foster commercial innovation in the private sector. The academic R&D measure also proved to be statistically insignificant. For these reasons, private industry R&D is a better indicator of the knowledge economy and is therefore included as the proxy for innovation in the final model.

The fast growth firms variable is a conceptually appealing indicator of entrepreneurial activity in a state. The variable is based on two entrepreneurship lists. The Inc. 500 list (2008) is a long-standing, well respected report that measures the fastest growing private companies in the country. The Deloitte Technology Fast 500 (2008) list also includes fast growth firms and concentrates on companies in the technology, media and entertainment, telecommunications and life sciences sectors, all of which are knowledge economy industries. Firms included in either list form the fast growth firm variable.

One independent variable, median age, proved to be a relevant and important control of per capita income. Median age was significant in all preliminary conceptual models, revealing that age is an important determinant of a state's per capita income. Mean annual temperature was used as a control variable in earlier models but was eventually discarded because it proved to be insignificant.

The Surviving Statistical Model

Preliminary testing of conceptual models led me to create a final model with three knowledge economy variables. The model that includes these three variables, defined as the knowledge economy regression model, yields strong statistical and theoretical properties for building a knowledge economy index. The model with per capita income as the dependent variable, the three surviving knowledge economy indicators and the median age control variable is written as follows. The regression results are below in Table 5.

PCI = F(EDU, FGF, R&D, MEDAGE)

Table 5: Regression Results of Knowledge Economy Model on Per Capita Income

Regressor	Coefficient	Robust Std. Err.	t
Workforce Education	38693.54	6545.037	5.91**
Fast Growth Firms	3806823	1726650	2.20**
Industry R&D	23124.43	18339.74	1.26
Median Age	355.3181	161.4307	2.20**
Constant	-4944.469	6522.207	-0.76
Summary Statistics			
SER	1769		
R^2	0.7625		
F-statistic	30.94		
n	50		
**5% significance level			
*10% significance level			

The results indicate that each component of the knowledge economy positively affects state per capita income. Educational attainment of the workforce is clearly a crucial element of a successful knowledge economy. Additionally, the presence of fast growth firms in a state appears to be an important indicator of entrepreneurship and economic development. Industry research and development was not significant in the final model but was a strong statistical indicator in earlier models and is a relevant and conceptually appealing knowledge economy measure. Industry research and development is the best readily-available measure of innovation for a knowledge economy index and, therefore, is included in the final model.

The workforce education coefficient indicates that, all else equal, a ten percentage point increase in the weighted education measure will lead to an estimated increase in state per capita income of $3,869. If, therefore, South Carolina's workforce education measure increased from .345 to .445, a gain that could be achieved by a ten percentage point increase in the proportion of the state's labor force over 25 years of age that has a bachelor's degree, then state per capita income would be predicted to increase by almost $4,000. Workforce education is clearly a crucial element of the knowledge economy and significantly affects a state's standard of living.

Fast growth firms are a small percentage of a state's total number of firms, but the presence of such firms appears to significantly affect per capita income. From 2005-2006, eleven such firms were located in South Carolina, 0.012 percent of total firms in the state. An interpretation of the coefficient of this variable indicates that, all else equal, increasing the proportion of fast growth firms in the state to 0.022 percent would raise per capita income by $380. Such a gain could be achieved by increasing the number of fast growth firms in South Carolina to twenty in 2007-2008.[7]

A marker species is a species whose presence in an ecosystem indicates a broader significance or trend. For example, scientists often search for marker species in water

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[7] The fast growth firms variable selected from the 2007 State New Economy Index includes the number of 500 list firms in a state over a two year period weighted by the number of firms in a state in a given year. The fast growth firms variable I constructed for previous year data, which should also be used in future Clemson Knowledge Economy Indexes, counts the number of 500 list firms in a state in only one year. This methodology should be used in the future so that the index can be replicated annually. It should be noted that the slight discrepancy in the structure of the fast growth firms variable did not affect the regression results because variation in the two variables was almost identical.

sources to indicate levels of water quality and sanitation (Barrett et al. 1998). Fast growth firms are an entrepreneurship marker species. The Inc. 500 and Deloitte Technology Fast 500 lists that generate the fast growth firms variable are influential measures of entrepreneurship, but it is rather difficult to greatly increase the number of 500 list firms in a state because such firms make up such a small proportion of the economy. Economic policy efforts should not simply aim to get more South Carolina firms on the lists. Development would likely be more effective and productive if efforts focused on encouraging a wide range of firms in the state to grow rapidly, specifically in knowledge sectors; then the marker species, an increase of the number of 500 list firms in South Carolina, should appear nevertheless.

Increasing research and development expenditures relative to total worker earnings by one percentage point, holding all else constant, is predicted to increase state per capita income by $231, implying the importance of private industry R&D to the knowledge economy. This increase could be achieved in South Carolina by augmenting industry research and development by approximately $2 million, holding worker earnings constant. Total industry R&D was $961 million in South Carolina in 2005.[8] States that increase such research and development expenditures relative to worker earnings consistently enjoy higher per capita incomes.

Making the Transition to the Index

In building the knowledge economy index, the raw regression results of the statistical model must be converted into a final index. In order to make this transition from regression analysis to the index, the coefficients of the three independent variables of the model are

[8] National Science Foundation (2005)

used as weights to determine the relative explanatory power of each knowledge economy indicator. The knowledge economy regression model includes a control variable that is not a component of the index, which ensures that the index is not just a scaling of the dependent variable. The knowledge economy variable coefficients are multiplied by the raw data for each state, which results in the respective proportions of per capita income generated by knowledge, innovation and entrepreneurship. The three knowledge economy components are then summed for each state. This result demonstrates the portion of state per capita income that is accounted for by the combined knowledge economy indicators, and all fifty states are then ranked based on the results from the model. Rankings are below in Table 6. South Carolina ranked 39, same as in the 2007 State New Economy Index.

Table 6: Clemson Knowledge Economy Index State Ranks

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

The knowledge economy index model, therefore, includes four independent variables, three of which are knowledge economy variables and one of which is a control for the effect of age on state per capita income. The model explains seventy-six percent of the variation in state per capita income and is written:

Per Capita Income = F(Workforce Education,

Fast Growth Firms, Industry R&D, Median Age)

The surviving variables are logically appealing. The model indicates that per capita income is driven by investment in human capital beyond secondary school and including doctoral education, the presence of entrepreneurial firms in a state, increases in private research and development expenditures and the larger work age population. The estimated coefficients of these three variables are used in determining the weights for the Clemson Knowledge Economy Index. From the standpoint of state policy, the model suggests that per capita income can be increased by enhancing educational opportunities, encouraging the start-up of new ventures that draw from R&D and other innovation sources, and increasing efforts to promote R&D joint ventures with private firms and universities.

The state rankings generated from the regression model are simply an ordering of states, but the actual index scores demonstrate the degrees of magnitude that separate the performance levels of state knowledge economies. The results of the Clemson Knowledge Economy Index are given below in Table 7. The index is relative to South Carolina so that the state's score can be quickly and easily compared to other states. The U.S. average was also calculated and shows that South Carolina's knowledge economy performance lags behind the national average.

Table 7: Clemson Knowledge Economy Index

State	2007 Index Score	State	2007 Index Score
Massachusetts	170.0	Pennsylvania	112.7
Maryland	156.7	Montana	111.3
Virginia	155.2	North Carolina	110.2
Colorado	150.7	North Dakota	110.0
Connecticut	149.8	Florida	109.2
New Jersey	147.6	New Mexico	108.3
New Hampshire	136.5	Idaho	108.1
Minnesota	136.3	Wisconsin	108.1
California	133.9	Maine	108.0
Washington	133.3	Ohio	104.3
New York	132.6	Iowa	103.4
Vermont	132.3	South Dakota	103.0
Utah	132.2	Missouri	102.8
Delaware	128.2	**South Carolina**	**100.0**
Rhode Island	126.0	Wyoming	99.0
Illinois	124.2	Oklahoma	97.5
Oregon	122.3	Indiana	97.5
Georgia	118.8	Tennessee	95.2
Arizona	118.3	Alabama	95.0
Alaska	117.5	Nevada	93.6
Kansas	116.9	Mississippi	88.0
Nebraska	115.4	Kentucky	86.8
Hawaii	114.5	Louisiana	85.3
Michigan	114.1	Arkansas	80.5
Texas	113.3	West Virginia	73.0
U.S. Average	115.7		

Historical Replication

To test the validity and credibility of the index model over time, I performed statistical tests for year 2000 data. In order to do so, I gathered period data for all variables and attempted to construct the dependent variables exactly as they were in the 2007 SNEI and then ran the same statistical model with the earlier data. I encountered a challenge with building the industry R&D indicator because of the complexity of the variable, which caused me to assume that a future researcher would have a similar challenge. Recall that one goal of this project is to build a simple model so that future state knowledge economy index researchers can expediently build future indexes at low cost. In the interest of reducing the cost of replicating the index, I built a new, more straightforward variable that still measures industry research and development. The new variable is industry research and development expenditures weighted by total worker earnings. After redefining the industry R&D variable (R&D'), I ran the model, which is written:

PCI = F(EDU, FGF, R&D', MEDAGE)

All three dependent variables and the control variable are significant in the 2000 data set model. The new research and development variable was significant at the ten percent level, stronger than the original R&D variable in the 2007 model. The 2000 model regression results are found in Table 8.

Table 8: Regression Results of Knowledge Economy Index Model on Per Capita Income, 2000

Regressor	Coefficient	Robust Std. Err.	t
Workforce Education	26148.84	5937.745	4.40**
Fast Growth Firms	9440281	3535715	2.67**
Industry R&D'	23.3938	12.80197	1.83*
Median Age	352.1525	138.917	2.53**
Constant	-2514.698	5399.867	-0.47
Summary Statistics			
SER	1570.8		
R^2	0.7208		
F-statistic	27.96		
n	50		

**5% significance level
*10% significance level

Examination of the t-statistics reveals that this is a statistically sound model. Furthermore, the r-squared value of 0.72 indicates that the model has strong explanatory power. The state knowledge economy index model appears to have historical relevance and validity, suggesting that the model will be effective in future knowledge economy indexing.[9] The 2000 Clemson Knowledge Economy Index rankings are displayed in Table 4 of the Appendix, along with state rankings from the 2001 Milken Institute Knowledge-based Economy Index (2001) for comparison purposes.

Once determining that the model was historically accurate and relevant, I examined the index scores for South Carolina for recent years. By gathering data for South Carolina and plugging it into the index model, I was able to calculate index scores for the state for the years 2000, 2003 and 2005 in addition to the original 2007 score. These scores are below in Table 9 and portray the progress of South Carolina's knowledge economy from 2000-2007.

Table 9: Clemson Knowledge Economy Index, 2007-2000

Year	Index Score
2007	100.0
2005	97.3
2003	96.9
2000	86.9

Diagnostics

In diagnostic work, I examined the degree to which the model fits South Carolina data and identified peer states on the basis of statistical fit and residual analysis. I defined an outlier state as one whose residual was greater than one standard deviation from the residual mean. My assessment indicates that South Carolina is not an outlier of the model, which

[9] The new industry R&D variable (R&D') was constructed for the 2007 data set and then used in the model as a proxy for the original R&D variable. The 2007 model with the new measure, however, suffered in terms of the statistical significance of the R&D' variable, but coefficients were approximately the same as in the previous model. Due to the complex nature of the 2007 State New Economy Index industry R&D variable, it is recommended that future state knowledge economy index researchers use the simpler variable (R&D') for future indexes.

indicates a satisfactory fit to the model and implies that the state knowledge economy index model has explanatory power of per capita income in South Carolina.

An examination of residuals of the model shows that Georgia, Alabama, New Hampshire, Kentucky and Louisiana are immediately nested around South Carolina. These states are defined as peer states and have similar statistical properties, implying that they fit the model approximately as well as South Carolina. Conceptually, this suggests that the structure of the knowledge economies in these peer states are similar to that of South Carolina. But are these economies performing at the same level? Table 10 shows the index numbers for South Carolina and its residual analysis peers.

Table 10: Clemson Knowledge Economy Index, South Carolina and Peer States

State	2007 Index Score
New Hampshire	136.5
Georgia	118.8
South Carolina	100.0
Alabama	95.0
Kentucky	86.8
Louisiana	85.3

The index results show that New Hampshire's and Georgia's knowledge economies significantly outperform South Carolina's. Alabama's knowledge economy is performing at a level beneath South Carolina's, but is fairly close. Kentucky and Louisiana lag behind considerably. One can speculate about the similarities of these states' economies. For example, New Hampshire and South Carolina both have strong tourism industries, and South Carolina, Georgia, Alabama, Kentucky and Louisiana are all southern states involved in agricultural production to varying degrees. This peer state analysis suggests a handful of states whose knowledge economies can be logically and conceptually compared to that of South Carolina.

Summary and Conclusion

On the basis of the work included in this chapter, I have developed statistical models that have strong explanatory power in measuring the effectiveness of a knowledge economy. The development of these models led me to construct a final state knowledge economy index model, and more statistical testing and diagnostic work allowed me to fine-tune the model to provide the best state knowledge economy index measure possible. I then developed state rankings and Clemson Knowledge Economy Index scores from the regression model. Historical testing examined the model's relevance and credibility over time, and the model proved to be effective. A diagnostic examination of the state knowledge economy index model indicated that South Carolina fits the model acceptably. Peer states were also identified through residual analysis, and policy makers can compare and contrast characteristics of the knowledge economies of these states with that of South Carolina when making policy decisions.

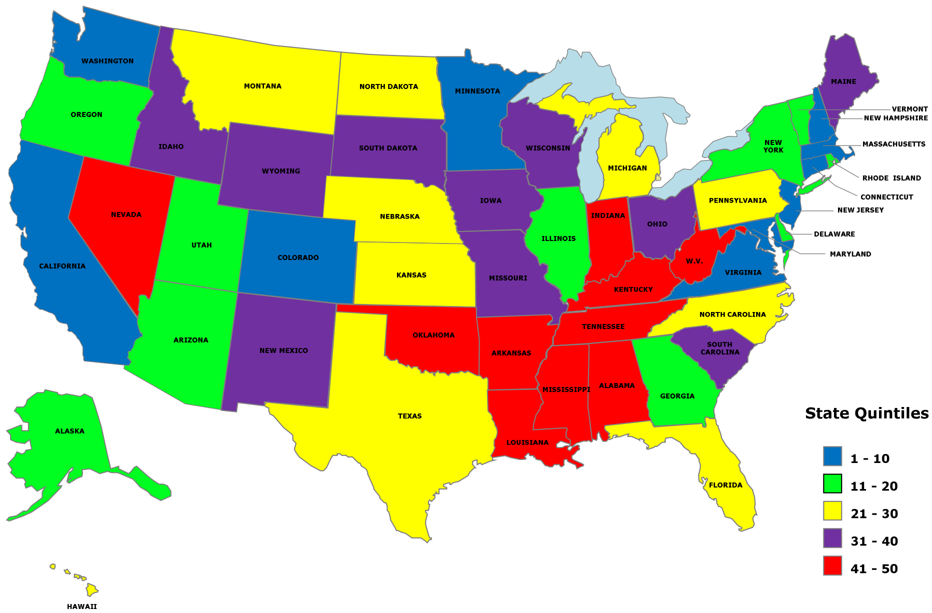
Future users of the knowledge economy model should recognize that the index model is inherently fragile. The fluid nature of the structure of an economy and the multitude of factors that can conceivably affect an economy's performance will definitely have an effect on the knowledge economy index model. As state economies change, adapt and innovate more and more rapidly, the model will deteriorate more and more rapidly. A decision as to the approach to take in building the next index must ultimately be made by the next researcher; however, I recommend that the nominal coefficients from the current model be used for three years in building the Clemson Knowledge Economy Index. After three years, I advise that future researchers collect an entire data set for the knowledge economy variables and re-estimate the model in order to determine its continued relevance and effectiveness at measuring the performance of the knowledge economy.

Chapter Four

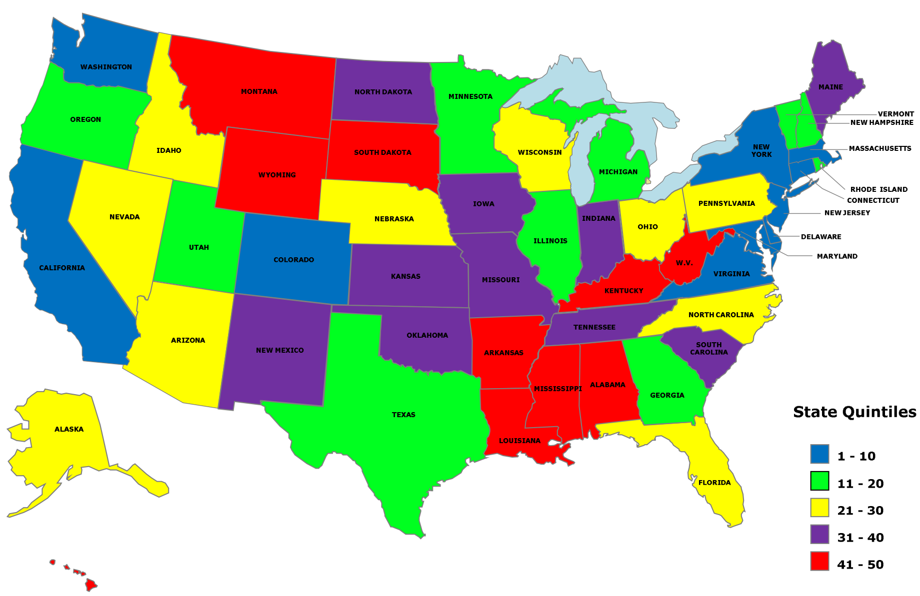
CONCLUSION

It should be recognized that a state's economy is enormous and is affected by numerous factors, which may limit the effect of the knowledge economy on economic growth and development. The Clemson Knowledge Economy Index is a simple yet effective quantitative measure of the performance and effectiveness of state knowledge economies. The index is extremely useful in that it uses just three knowledge economy variables and is able to reproduce similar results of much more complicated knowledge economy indexes that are composed of many more indicators. Figure 2 displays the similarities between state quintile rankings of the 2007 Clemson Knowledge Economy Index and the 2007 State New Economy Index.

Figure 2: Mapping of State Quintile Rankings, 2007 Clemson Knowledge Economy Index vs. 2007 State New Economy Index



2007 Clemson Knowledge Economy Index



2007 State New Economy Index

All states of the Union, to varying degrees, are transitioning toward a knowledge economy. Economic literature, knowledge economy reports and my own study suggest that human capital investment in education is the most significant driver of the knowledge economy. Thomas Green Clemson's endowment of Clemson Agricultural College was an effort to increase the standard of living of the people of South Carolina and give them an opportunity to build better lives for themselves. State policy makers and private individuals make similar efforts today, and an effective knowledge economy clearly drives economic growth and development that has the potential to raise the standard of living of the state.

As the economies of the states continue to transform and are increasingly fueled by knowledge and innovative human capital, some states will surely advance and adapt more rapidly and successfully than others. As manufacturing industry continues to be replaced by the knowledge sector, South Carolina policy makers should recognize that economic growth and development will occur in certain sectors at the expense of others, but hopefully the process is positive-sum. Czech economist Joseph Schumpeter (1942) defined this phenomenon as Creative Destruction when he referenced the emerging widespread industrial sector in the early 20th century U.S.:

> The opening up of new markets, foreign or domestic, and the organizational development from the craft shop and factory to such concerns as U.S. Steel illustrate the same process of industrial mutation—if I may use that biological term—that incessantly revolutionizes the economic structure from within, incessantly destroying the old one, incessantly creating a new one…this process of Creative Destruction is the essential fact about capitalism.

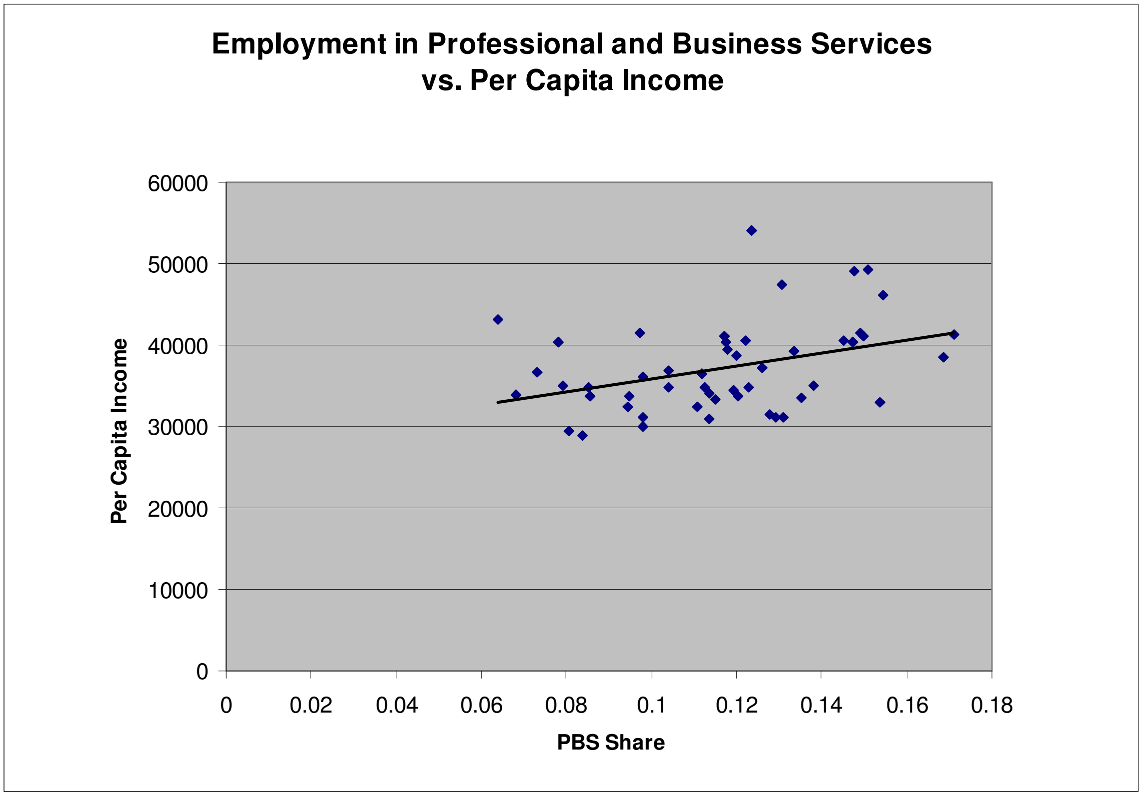
In order for the state of South Carolina to progress and prosper further economically, policies should be constructed and implemented to ensure that the state's economic efforts focus on the creative initiative of Schumpeter's principle, rather than the destruction component. The emergence and development of a regionally and nationally competitive knowledge economy is a promising means to ensure that South Carolina's economy adapts and evolves innovatively and, consequently, avoids becoming entrenched in sectors that are rapidly losing value and becoming obsolete. I hope that the Clemson Knowledge Economy Index will be a valuable tool to measure the state's effectiveness at achieving this end.

APPENDIX

Table 1: Correlation Matrix of Variables

Variable	PCI	PC GDP	MED AGE	MEAN TEMP	R&D	VC	PAT	FGF	EDU	MPT JOBS	HT JOBS	GJ	JC	SCI ENG
Per Capita Income	1.00													
Per Capita GDP	0.81	1.00												
Median Age	0.23	0.06	1.00											
Mean Temperature	-0.25	-0.21	-0.26	1.00										
Industry R&D	0.57	0.64	0.04	-0.14	1.00									
Venture Capital	0.52	0.40	-0.15	-0.45	0.37	1.00								
Patents	0.31	0.34	-0.22	-0.24	0.44	0.38	1.00							
Fast Growth Firms	0.60	0.46	-0.28	0.09	0.35	0.63	0.31	1.00						
Workforce Education	0.84	0.66	0.05	-0.38	0.52	0.60	0.43	0.61	1.00					
Man, Prof, and Tech Jobs	0.72	0.57	0.13	-0.16	0.66	0.52	0.37	0.60	0.75	1.00				
High-tech Jobs	0.70	0.54	-0.15	-0.12	0.60	0.70	0.56	0.75	0.82	0.75	1.00			
Gazelle Jobs	0.43	0.55	-0.16	0.09	0.41	0.25	0.15	0.39	0.40	0.42	0.42	1.00		
Job Churning	0.10	0.05	-0.35	0.11	-0.02	0.21	0.37	0.33	0.06	-0.04	0.23	0.15	1.00	
Scientists and Engineers	0.57	0.48	0.08	-0.19	0.51	0.55	0.41	0.48	0.68	0.71	0.70	0.28	0.17	1.00

Table 2: Employment in Professional and Business Services plotted against Per Capita Income



Sources:

Bureau of Labor Statistics (2007). <http://www.bls.gov/news.release/laus.toc.htm>. Accessed 16 Apr 2008.

Bureau of Economic Analysis (2007). <http://www.bea.gov/regional/index.htm>. Accessed 16 Apr 2008.

Table 3: State Ranks by the 2007 Clemson Knowledge Economy Index, 2007 State New Economy Index, Per Capita Income and Per Capita GDP

State	2007 CNEI	2007 SNEI	Income	GDP
Alabama	44	46	40	45
Alaska	20	25	13	5
Arizona	19	22	24	37
Arkansas	49	47	48	47
California	9	5	12	10
Colorado	4	9	8	8
Connecticut	5	6	1	2
Delaware	14	7	14	1
Florida	30	23	18	35
Georgia	18	18	27	23
Hawaii	23	41	11	17
Idaho	32	24	44	42
Illinois	16	16	15	13
Indiana	42	31	34	30
Iowa	36	38	31	24
Kansas	21	34	26	34
Kentucky	47	45	41	43
Louisiana	48	44	47	39
Maine	34	32	30	41
Maryland	2	3	2	14
Massachusetts	1	1	4	3
Michigan	24	19	25	32
Minnesota	8	11	9	9
Mississippi	46	49	50	50
Missouri	38	35	33	36
Montana	27	42	42	48
Nebraska	22	28	29	20
Nevada	45	27	16	11
New Hampshire	7	13	6	16
New Jersey	6	2	3	6
New Mexico	31	33	46	40
New York	11	10	7	4
North Carolina	28	26	32	21
North Dakota	29	37	35	33
Ohio	35	29	28	28
Oklahoma	41	40	45	46
Oregon	17	17	23	18
Pennsylvania	26	21	21	27
Rhode Island	15	15	17	22
South Carolina	**39**	**39**	**39**	**44**
South Dakota	37	48	38	26
Tennessee	43	36	37	29
Texas	25	14	36	19

Table 3 Continued: State Ranks by the 2007 Clemson Knowledge Economy Index, 2007 State New Economy Index, Per Capita Income and Per Capita GDP

State	2007 CKEI	2007 SNEI	Income	GDP
Utah	13	12	43	38
Vermont	12	20	19	31
Virginia	3	8	5	7
Washington	10	4	10	15
West Virginia	50	50	49	49
Wisconsin	33	30	20	25
Wyoming	40	43	22	12

Table 4: State Ranks by the 2000 Clemson Knowledge Economy Index and 2001 Milken Institute Knowledge-based Economy Index

State	2000 CKEI	2001 Milken KEI	State	2000 CKEI	2001 Milken KEI
Alabama	45	32	Montana	28	36
Alaska	22	34	Nebraska	29	40
Arizona	23	13	Nevada	44	37
Arkansas	49	50	New Hampshire	9	10
California	10	2	New Jersey	7	9
Colorado	2	3	New Mexico	19	21
Connecticut	3	4	New York	14	6
Delaware	13	8	North Carolina	26	24
Florida	30	25	North Dakota	34	45
Georgia	24	20	Ohio	37	27
Hawaii	20	30	Oklahoma	42	41
Idaho	25	29	Oregon	17	14
Illinois	16	17	Pennsylvania	31	19
Indiana	41	35	Rhode Island	15	16
Iowa	38	38	**South Carolina**	**40**	**42**
Kansas	18	26	South Dakota	39	49
Kentucky	47	44	Tennessee	43	33
Louisiana	46	39	Texas	27	12
Maine	32	43	Utah	12	11
Maryland	4	5	Vermont	8	23
Massachusetts	1	1	Virginia	5	15
Michigan	21	22	Washington	6	7
Minnesota	11	18	West Virginia	50	48
Mississippi	48	47	Wisconsin	33	31
Missouri	36	28	Wyoming	35	46

DATA SOURCES FOR VARIABLES

Dependent Variables

Per Capita Income:

Per capita income in the past 12 months in 2006 inflation-adjusted dollars.

U.S. Census Bureau, *American Community Survey* (2006). <www.census.gov/acs>.

Per Capita Gross Domestic Product:

Per capita gross domestic product.

U.S. Department of Commerce, Bureau of Economic Analysis, *Regional Economic Accounts* (2005). <http://www.bea.gov/regional/index.htm >.

Control Variables

Median Age:

Median age of the population.

U.S. Census Bureau, *American Community Survey* (2006). <www.census.gov/acs>.

Mean Temperature:

Average mean temperature index by month. Climatology by state based on climate division data: 1971-2000.

National Oceanic and Atmospheric Administration, National Climatic Data Center. <http://www.cdc.noaa.gov/USclimate/tmp.state.19712000.climo>.

Candidate Variables[10]

Fast Growth Firms:

The number of Deloitte Technology Fast 500 and Inc. 500 firms as a share of total firms. The numbers from the Fast 500 and

[10] Descriptions and sources for candidate variables come from the 2007 State New Economy Index (2007).

the Inc. 500 represent data from both 2005 and 2006 surveys. To qualify for the Fast 500, a company must a) own proprietary intellectual property or technology, b) be incorporated for a minimum of 5 years, and c) have operating revenues in a base year of $50,000 and current year operating revenues exceeding $5 million. To qualify for the Inc. 500, a company must be privately held and in operation for a minimum of 4 years with at least $600,000 in revenues in the base year. The Fast 500 is selected through research and a nomination process and open to firms in North America, while the Inc. 500 list is chosen on an application basis and open only to U.S. firms.

Fast 500: Deloitte, "2006 Deloitte Technology Fast 500,"

<www.public.deloitte.com/fast500>.

Inc. 500: *Inc. Magazine*, "2006 Inc. 500 List," <www.inc.com/resources/inc500/2006>.

Total Firms: U.S. Small Business Administration, Office of Advocacy, "The Small Business

Economy, 2005." <www.sba.gov/advo/research/sb_econ2005.pdf>.

Gazelle Jobs:

Jobs in gazelle companies (firms with annual sales revenue that have grown 20 percent or more for four straight years) as a share of total employment. The measured period of growth spans from January 1, 2002 to January 1, 2006.

Gazelles: National Policy Research Council (2006).

Employment: U.S. Department of Commerce, Bureau of Economic Analysis, *Regional*

Economic Accounts (2005). <www.bea.gov/bea/regional/data.htm>.

High-Tech Jobs:

Jobs in electronics manufacturing, software and computer related services, telecommunications, and biomedical industries as a share of total employment. This indicator includes the NAICS codes from the AeA definition found in "Cyberstates," plus the following biomedical industries: NAICS codes 32541, 333314, 33911, 54172, and 62151. Altogether this includes computer and office equipment, consumer electronics, communications equipment, electronic components and accessories, semiconductors, industrial electronics, photonics, defense electronics, electro medical equipment, pharmaceuticals, optical instruments and lenses, navigational, medical, measuring and control instruments, medical equipment and supplies, scientific R&D services, medical and diagnostic laboratories, communications services and software and computer related services. Employment in these industries is measured as a share of each state's overall employment.

High-Tech Jobs: AeA, *Cyberstates 2006* (Washington DC: 2006), and U.S. Department of Labor, Bureau of Labor Statistics, *Quarterly Census of Employment and Wages*, (2004). <www.bls.gov/cew>.

Total Employment: U.S. Department of Commerce, Bureau of Economic Analysis, *Regional Economic Accounts* (2004). <www.bea.gov/bea/regional/data.htm>.

Industry Research and Development:

Industry-performed research and development as a percentage of total worker earnings. To better measure the propensity of all companies to invest in R&D, R&D scores are calculated by controlling for the overall industrial mix in each state. This is done by measuring the overall propensity to invest in R&D of each industry sector, and multiplying the number of jobs in each sector for each state by that sector's national propensity to invest in R&D factor. These were summed to create an adjusted total number of jobs for each state. A ratio was calculated comparing the unadjusted to the adjusted. If the ratio was larger than one, the state's industrial mix was slanted toward industries that tend to invest in R&D less. If it was smaller than one, the state had more jobs than the national average in industries that invest in R&D more. The total value of investment in R&D was multiplied by the ratio for a final adjusted score.

Industry R&D: National Science Foundation, *Science and Engineering Indicators* (2006).

Employment: U.S. Department of Labor, Bureau of Labor Statistics, *Quarterly Census of Employment and Wages* (2003). <www.bls.gov/cew>.

Worker Earnings: U.S. Department of Commerce, Bureau of Economic Analysis, *Regional Economic Accounts* (2003). <www.bea.gov/bea/regional/data.htm>.

Job Churning:

The number of new start-ups and business failures, combined, as a share of the total firms in each state. To counteract any potential anomalies, the number of business start-ups and failures were measured for two years, 2003 and 2004, and averaged. In past editions of the *Index*, job churning measured business establishments, not firms. However, in this edition SBA firm data are used because they are more recent than the available Census establishment data (2002 2003).

U.S. Small Business Administration, Office of Advocacy, "The Small Business Economy, 2005." <www.sba.gov/advo/research/sb_econ2005.pdf>.

Managerial, Professional, and Technical Jobs:

Managers, professionals, and technicians as a share of the total workforce.

Managerial, Professional, and Technical Jobs: U.S. Department of Labor, Bureau of Labor Statistics *Occupational Employment Statistics* (2005). <www.bls.gov/oes>.

Total Employment: U.S. Department of Commerce, Bureau of Economic Analysis, *Regional Economic Accounts* (2005). <www.bea.gov/bea/regional/data.htm>.

Patents:

Number of patents issued to companies or individuals per 1,000 workers. To better measure the propensity of all companies to patent, patent scores are calculated by controlling for the overall industrial mix in each state. This is done by measuring the overall propensity to patent of each industry sector, and multiplying the number of jobs in each sector for each state by that sector's national propensity to patent factor. These were summed to create an adjusted total number of jobs for each state. A ratio was calculated comparing the unadjusted to the adjusted. If the ratio was larger than one, the state's industrial mix was slanted toward industries that tend to patent less. If it was smaller than one, the state had more jobs than the national average in industries that patent more. The total value of patents was multiplied by the ratio for a final adjusted score.

Patents: United States Patent and Trademark Office, *Patent Counts by Country/State and Year: Utility Patents* (2005).

Employment: U.S. Department of Labor, Bureau of Labor Statistics, *Quarterly Census of Employment and Wages* (2005). <www.bls.gov/cew>.

Scientists and Engineers:

Scientists and engineers as a percentage of the workforce. Scientists and engineers include only those who have attained a doctorate in their field. They are measured as a share of each state's total workforce.

Scientists and Engineers: National Science Foundation, *Science and Engineering State Profiles* 2003-2004 (May 2006). <www.nsf.gov/statistics/nsf06314>.

Total Employment: U.S. Department of Commerce, Bureau of Economic Analysis, *Regional Economic Accounts* (2003). <www.bea.gov/bea/regional/data.htm>.

Venture Capital:

Venture capital invested as a share of worker earnings. Venture capital investment is measured over the course of 2005 and the first 2 quarters of 2006.

Venture Capital: PricewaterhouseCooper/Venture Economics/NVCA MoneyTree Survey (2006).

Worker Earnings: U.S. Department of Commerce, Bureau of Economic Analysis, *Regional Economic Accounts* (2004). <www.bea.gov/bea/regional/data.htm>.

Workforce Education:

Each state's population, aged 25 years or older, was classified by educational attainment. The percentage of residents with some college (at least a year) but no degree were weighted with a multiplier of 0.25. Those possessing associate's degrees were given a weight of 0.5. The multiplier for the percentage of residents with a bachelor's degree was 1.0, and the multiplier for master's and professional degrees was 1.5. Doctorates received a weight of 2.0. The weighted percentages for each state's population were added to find each state's total score. In other words, a state where 15 percent of the residents had some college but no degree (earning a weighted score of 3.75), 10 percent held an associate's degree (a weighted score of 5), 20 percent held a bachelor's degree (a weighted score of 20), 10 percent held a master's or professional degree (a weighted score of 15) and 1 percent held a doctorate (a weighted score of 2), would earn a total score of 45.75.

U.S. Census Bureau, *American Community Survey* (2005). <www.census.gov/acs>.

REFERENCES

Atkinson, Robert D. and Daniel K. Correa. 2007. "The 2007 State New Economy Index." Ewing Marion Kauffman Foundation. Kansas City. <http://www.kauffman.org/items.cfm?itemID=766>. Accessed 15 Apr 2008.

Baier, Scott L., Gerald P. Dwyer and Robert Tamura. 2006. "Factor Returns, Institutions, and Geography: A View From Trade." The Institute for International Integration Studies Discussion Paper Series iiisdp166, IIIS.

Barkley, David L. and Mark S. Henry with Rebekka Dudensing and Daniel Eades. 2008. "Greater Greenville Regional Economic Scorecard." EDA University Center for Economic Development, Clemson University. <http://www.greenvillechamber.org/pdf/Scorecard.pdf>. Accessed 15 Apr 2008.

Barkley, David L. and Mark S. Henry. 2005. "Innovative Metropolitan Areas in the South: How Competitive are South Carolina's Cities?" Regional Economic Development Research Laboratory, Department of Applied Economics and Statistics, Clemson University. <http://cherokee.agecon.clemson.edu/redrl_rpt17.pdf>. Accessed 18 Oct 2007.

Barrett, Mike H., Kevin M. Hiscock, Stephen Pedley, David N. Lerner, John H. Tellam and Mike J. French. 1998. "Marker Species for Identifying Urban Groundwater Recharge Sources: A Review and Case Study in Nottingham, UK." *Water Research*. Vol. 33, No. 14, pp. 3083-3097, 1999.

Becker, Gary S. 1994. *Human Capital: A Theoretical and Empirical Analysis, with Special Reference to Education*. Chicago: University of Chicago Press.

Bureau of Labor Statistics. 2008. "Employees on nonfarm payrolls by major industry sector, 1958 to date." Establishment Data: Historical Employment. Washington. <ftp://ftp.bls.gov/pub/suppl/empsit.ceseeb1.txt>. Accessed 15 Apr 2008.

Camp, Michael S. 2005. "The Innovation-Entrepreneurship Nexus: A National Assessment of Entrepreneurship and Regional Economic Growth and Development." Small Business Administration Office of Advocacy. Washington. <http://www.sba.gov/advo/research/rs256tot.pdf>. Accessed 18 Oct 2007.

Clemson, Thomas Green. 1888. "Last Will and Testament of Thomas G. Clemson." Clemson University. Clemson. <http://www.clemson.edu/administration/ogc/tgc_will.html>. Accessed 11 Apr 2008.

Cox, W. Michael and Richard Alm. 2003. "A Better Way: Productivity and Reorganization in the American Economy." Federal Reserve Bank of Dallas Annual Report. Dallas: Federal Reserve Bank of Dallas. <http://www.dallasfed.org/fed/annual/2003/ar03.pdf>. Accessed 5 March 2008.

Cox, W. Michael and Richard Alm. 1999. "A New Paragdigm." Federal Reserve Bank of Dallas Annual Report. Dallas: Federal Reserve Bank of Dallas. <http://www.dallasfed.org/fed/annual/1999p/ar99.pdf>. Accessed 5 March 2008.

Cox, W. Michael and Richard Alm. 2006. "The Best of All Worlds: Globalizing the Knowledge Economy." Federal Reserve Bank of Dallas Annual Report. Dallas: Federal Reserve Bank of Dallas <http://www.dallasfed.org/fed/annual/2006/ar06.pdf>. Accessed 18 Oct 2007.

Deloitte Technology Fast 500. 2008. <http://www.deloitte.com/dtt/section_node/0,1042,sid%253D56072,00.html>. Accessed 15 April 2008.

Fairlie, Robert W. 2005. "Kauffman Index of Entrepreneurial Activity: State Report, 2005." Ewing Marion Kauffman Foundation. Kansas City. <http://www.kauffman.org/pdf/KIEA_state_052206.pdf>. Accessed 16 Apr 2008.

Fisher, Peter. 2005. *Grading Places: What Do The Business Climate Rankings Really Tell Us?* Washington: Economic Policy Institute.

Gwartney, James and Robert Lawson. 2007. "The Economic Freedom of the World: 2007 Annual Report." Fraser Institute. Vancouver. <http://www.freetheworld.com/>. Accessed 15 Apr 2008.

Holmes, Kim R., Edwin J. Feulner and Mary A. O'Grady. 2008. "2008 Index of Economic Freedom: The Link Between Economic Opportunity and Prosperity." The Heritage Foundation. Washington. <http://www.heritage.org/Index/>. Accessed 15 Apr 2008.

Inc. 500. 2008. <http://www.inc.com/inc5000/>. Accessed 15 Apr 2008.

Kahn, Charlotte. 2007. "A Time Like No Other: Charting the Course of the Next Revolution." The Boston Indicators Project. Boston. <http://www.tbf.org/IndicatorsProject/Default.aspx>. Accessed 15 Apr 2008.

Laffer, Arthur B. and Stephen Moore. 2008. "Rich States Poor States: ALEC-Laffer State Economic Competitiveness Index." American Legislative Exchange Council. Washington. <http://www.alec.org/fileadmin/newPDF/ALEC_Competitiveness_Index.pdf>. Accessed 15 Apr 2008.

McQuilliam, Lawrence J., Ying Huang and Robert McCormick. 2004. "U.S. Economic Freedom Index: 2004 Report." San Francisco: Pacific Research Institute.

Milken Institute. 2001. "Knowledge-based Economy Index." Milken Institute. Santa Monica. <http://www.milkeninstitute.org/research/research.taf?cat=indexes&function=detail&ID=19&type=NEI>. Accessed 18 Oct 2007.

National Science Foundation. 2007. Science and Engineering State Profiles: 2003-05. National Science Foundation. Arlington. <http://www.nsf.gov/statistics/nsf07322/>. Accessed 15 Apr 2008.

Pew Center on the States, The. 2008. "Grading the States 2008." The Pew Center on the States. Washington. <http://www.pewcenteronthestates.org/gpp_report_card.aspx>. Accessed 15 April 2008.

Porter, Michael E. 2003. "South Carolina Competitiveness Initiative." New Carolina. Columbia. <http://www.newcarolina.org/PDF/SCCompete-Ph1.pdf>. Accessed 15 Apr 2008.

Schumpeter, Joseph A. 1942. *Capitalism, Socialism and Democracy*. New York: Harper & Row.

Smith, Adam. 1784. *An Inquiry into the Nature and Causes of the Wealth of Nations*. London: A. Strahan and T. Cadell.

Stanford Encyclopedia of Philosophy. 2006. "William of Ockham." Stanford University. Stanford. <http://plato.stanford.edu/entries/ockham/>. Accessed 15 Apr 2008.

Technology Administration. 2004. "The Dynamics of Technology-based Economic Development: State Science & Technology Indicators Fourth Edition." Office of Technology Policy. Washington. <http://www.technology.gov/p_Reports.htm>. Accessed 18 Oct 2007.

World Bank, The. 2007. "KEI and KI Indexes (KAM 2007)." The World Bank. Washington. <http://info.worldbank.org/etools/kam2/KAM_page5.asp>. Accessed 15 Apr 2008.

Yandle, Bruce. 2007. "Where is the Knowledge Economy?" PowerPoint presentation. Prague, Czech Republic. July 2007.