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Understanding Louisiana Patent Production and the Role of Knowledge Stocks on Economic Growth

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by

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Abstract

The role of knowledge stocks on innovation and economic growth has emerged as an important public policy concern in the effort to create sustained regional growth and economic development. This paper attempts to provide an overview of the state of knowledge production in Louisiana through an analysis of patent statistics, which will be crucial in identifying how the continued production of new knowledge will have spillover effects on economic growth in metropolitan and non-metropolitan areas. Next, regression analysis is used to determine the interrelationship of county-level innovative capacity in the United States and per capita income growth. A simple convergence growth model was estimated with educational attainment and patent production added to incorporate the impact that tacit and explicit knowledge have on per capita income. Results were congruent with the hypothesized simple growth convergence model with a strong positive correlation between educational attainment and per capita income. However, knowledge production did not demonstrate a statistically significant impact on per capita income in non-metropolitan counties, and had a surprisingly diminutive impact in metropolitan counties. After comparing the advantages and disadvantages of the physical input, labor input and direct purchasing development strategies in relation to the regression analysis and results, it is argued that the physical input strategy would provide the greatest returns for regional economic development only if focused on industries that have a historical foundation in knowledge production and strategic investment in technology driven industries that are spatially proximate. Furthermore, policymakers must not forget the pervasive role that educational attainment plays in each of these strategies.

Introduction

With the emergence of the "new economy," in which technology and innovation are touted as the driving forces behind sustainable economic growth, it is essential that policy makers have a firm understanding of the effect that knowledge production has on innovation and the resultant spillover effects on regional growth and economic development in metropolitan and non-metropolitan areas. These results could have profound policy implications for proposed investment in knowledge production in metropolitan areas to serve as a catalyst for economic growth in its surrounding region. Scholars have increasingly heralded the role of innovative capacity for determining per capita income as a rationale for policy initiatives. However, a definitive study testing this hypothesis for the United States has yet to be undertaken.

This paper attempts to provide a comprehensive overview of the State of Louisiana's patent statistics by determining whether externalities over space and time exist in the production of knowledge, which is a crucial element in policy analysis. Regression analysis will be used to determine the relationship between knowledge production, human capital and per capita income in the United States. Rather than attempting to account for every identifiable variable, a parsimonious model that focuses upon the broader connection between innovative capacity and economic growth will be used. The predictive nature of this model will substantially increase the likelihood that unexpected variations are highly significant but unobservable attributes of the economy. Local patent production will serve as the proxy for a region's innovative capacity. The effect that educational attainment has on county-level per capita income will also be analyzed.

Finally, conclusions will be drawn from the inferential statistics. The effects of these conclusions on policy initiatives concerning regional economic growth and investment in knowledge production will be reviewed and directions for further research will be offered.

The Role of Knowledge Stocks on Economic Growth

A growing body of literature has been recently produced addressing the spillover impacts of knowledge production within and between non-metropolitan and metropolitan areas (Jaffe, Trajtenberg, and Henderson, 1993). This has been the result of the assertion of modern economic growth theories that technology and innovation serve as the driving forces behind sustainable economic growth in the new economy (Porter, 1990). Modern endogenous growth theories have refashioned Solow's model of innovation, which focuses upon exogenously determined innovation growth, to a model of innovation that is motivated by specific activities performed by economic actors in the economy (Fannin, 2003). In particular, intellectual property protection provides economic actors with the incentive to invest in research and development in order to increase the production of new innovations. Furthermore, Schunk, Woodward and Hefner (2006) posit that patent activity and research and development spending are definitive markers of county-level innovative capacity. This investment leads to the production of new knowledge which, when added to the existing knowledge stock, leads to the production of succeeding innovations. Although the new knowledge may be excludable due to intellectual property protections, the knowledge is still non-rival (Fannin, 2003). In other words, the utility an individual derives from the good (in this case, the knowledge produced) is not diminished by the number of individuals that consume the good.

The spillover of knowledge that leads to new knowledge production and economic output has also been argued to be spatially driven. Labor flows and input supply-end user relationships

are argued by Camagni (1991) as serving as the vehicle for knowledge transfers over space and time. Reamer, Icerman and Youtie (2003, p. 139) also concluded that "technology transfer is significantly facilitated by geographic proximity, (and) a strong centripetal forces pull a disproportionate share of technology development and commercialization activity into larger urban areas." It is this concept of spatial proximity and the role it plays in knowledge spillover that led Marshall (1920) to include it as one of the pre-conditions in the development of industrial districts. These industrial districts, which provide a geographic concentration of innovative activity, are argued by some economists to enhance economic development in the region through knowledge spillovers, product development and new firm spin-offs (Barkley and Henry, 2006). Marshall's industrial districts are also the academic antecedent to modern cluster theory as derived by Harvard Business School professor Michael Porter, which propounds regional growth as a special cluster phenomenon. This concept has been popularly employed by private business and government organizations in formulating many of their economic development models.

Support for spatially proximate knowledge spillovers has been growing in recent years. Jaffe, Trajtenberg and Henderson (1993) found that new knowledge was more likely based on previous knowledge produced within the same state or metropolitan statistical area. Furthermore, Anselin, Varga and Acs (2001) demonstrated that research and development efforts taking place 50 miles from the center of a metropolitan area significantly increased the level of knowledge production in the region.

This research has had a profound impact on how regions identify the factors necessary to spur endogenous growth. As communities have looked to imitate strategies in high economic growth regions in the U.S., the role that increased knowledge production plays in spurring

economic productivity is evident. These centers of innovation, such as the San Francisco Bay region, Boston and Austin, provide evidence that investment in university research leads to the production of new knowledge. In turn, this knowledge creates a spill-over effect through its use by start-up companies in the development of new innovative products and processes that in turn produce jobs and profits for investors (Fannin, 2003). These external benefits of knowledge spillovers provide for an environment that is conducive to the development of "regional innovation systems" (Audretsh, 2002).

The anecdotal success stories of these regions and the research evidence of knowledge spillovers has provided a blueprint for the process of strategic investment in creating a knowledge production based economy with the hope of accruing the corresponding economic spillovers. In order to be competitive in this new environment, a popular public policy response has been to develop clusters of economic activity to enable existing local businesses to increase productivity through increased competition. The resultant increase in innovative and entrepreneurial activity is illustrated by new business start-ups (Barkley and Henry, 2006).

This competition among states and metropolitan areas has forced a significant increase in strategic public investments in order to stimulate development and attract innovative activity. For example, Florida has committed over $500 million in public funding for the development of the Scripps Institute's East Coast research facility in Palm Beach to strengthen their life science and biotechnology sectors. Greenville, South Carolina has become a regional center for automotive innovation which resulted in South Carolina investing $69 million for the International Center for Automotive Research (ICAR). The Translational Genomics Research Institute (TGEN) was established in Phoenix, Arizona due to the more than $100 million in state, local government and private funding that was pledged. (NASVF; 2006) Furthermore, states

such as Michigan and Missouri are defining “life science corridors” to stimulate development and clustering of life science activities through strategic public investment. This has resulted in such partnerships as the Stowers Institute for Medical Research in the Kansas City metro area.[1] In fact, as of 2001, the Batelle Memorial Institute reports that 14 states have initiated some sort of bioscience plan. Furthermore, the National Association of Seed and Venture Funds (2006) reported an average state commitment to current capital programs of over $139 million.

States are making these strategic investments in specific regions with the hope that the increased economic activity resulting from knowledge spillovers will benefit the entire state. This poses an important policy question for Louisiana as to whether or not positive economic spillover effects will occur in regions outside of the urban centers with high levels of “innovative activity.” Louisiana is a state whose geography comprises vast rural regions that spatially separates distant metropolitan areas with high levels of patent production. It is imperative to be able to successfully define the spillover effects of investment in knowledge production in urban centers to the surrounding non-metropolitan areas and the role that knowledge production plays in overall economic growth. If spatial spillovers exist, then policy that promotes investment in knowledge production in metropolitan areas will have an overall economic benefit in the surrounding non-metropolitan areas. However, if Barkley and Henry’s (2006) conclusions are correct that “in terms of jobs and earnings, the urban-to-rural spillover of innovative activity may be limited if the nonmetro areas lack the high-technology industrial sectors in which the metro innovative activity occurs” such a policy would be ill-conceived. Furthermore, the structure of knowledge could preclude its application to only those individuals with an understanding of the technical language of the knowledge produced. This would result in the discontinuous spread of

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[1] The National Association of Seed and Venture Funds (www.nasvf.org) provides a record of recent state programs to promote innovative activity.

spillover effects to only those areas that can understand the technical details of the innovation (Breschi and Lissoni, 2001).

Louisiana Economic Development Policy

In light of this robust public commitment to economic development in other states, Louisiana has established a long-term strategic plan to provide vision and direction for its economic development efforts, *Louisiana: Vision 2020*. Since its creation in 1996, the Louisiana Economic Development Council has been required by law to review and update the state's master plan for economic development. Since its conception, the primary foundation of *Vision 2020* is composed of three goals. The first goal seeks to re-create the state into a "Learning Enterprise" in which its citizens and businesses are engaged in active learning. The second goal is focused on providing a model for economic development that includes business retention, attraction, creation and growth. Goal three is for the state to be ranked among the top ten states in the nation in 2020 when measured by standards of living indicators ("Executive Summary," *Louisiana: Vision 2020* 2003 Update). For the purposes of this paper, I will be focusing on the second goal of economic development – business retention, attraction, creation, and growth.

The Economic Development Council has identified eight objectives necessary to create a competitive Louisiana economy:

"2.1 To retain, modernize, and grow Louisiana's existing industries and grow emerging technology-based businesses through cluster-based development practices;

2.2 To significantly increase public and private research and development activity;

2.3 To increase the availability of capital for all stages of business development and provide management assistance to emerging businesses;

2.4 To provide effective mechanisms for industry access to university-based technologies and expertise;

2.5 To aggressively encourage and support entrepreneurial activity;

2.6 To develop and promote Louisiana’s transportation infrastructure;

2.7 To assess, build, and capitalize on Louisiana’s information and telecommunications infrastructure;

2.8 To have an equitable tax structure, regulatory climate, and civil justice system conducive to business retention and the creation and growth of innovative companies.” (*Louisiana: Vision 2020*; 2003)

These objectives focus on creating an economic environment that is conducive to entrepreneurship and the formation of emerging technology sectors. To attract these emerging technology-based businesses, the Louisiana Economic Development Department (LED) has chosen to focus on specific industry clusters that can share skilled workers, suppliers and support services. These clusters are defined as “a geographically bounded concentration of similar, related or complimentary businesses, with active channels for business transactions, communications and dialogue, that share specialized infrastructure, labor markets and services, and that are faced with common opportunities and threats” (*Louisiana: Vision 2020*; http://vision2020.louisiana.gov/goal2/obj2-1.htm).

The key industries that have been identified as crucial for stimulating economic development and attracting innovative activity are: advanced materials, agriculture/food/forestry/wood products, construction, durable goods/manufacturing, energy/oil and gas, entertainment, information technology, life sciences, and logistics/transportation (Louisiana Economic Development Department). Several of these industries, such as oil and gas, agriculture, transportation, and durable goods, have a solid foundation of sustained economic activity in Louisiana. On the other hand, many of these industries are not typically found in the Louisiana business landscape. Strategic investment in these non-traditional

industries is believed to be a source of increased levels of economic development and innovative activity. In the following pages I will attempt to provide an overview of the Louisiana Economic Development Department's strategic plan for these industrial clusters and the current state of these industries in Louisiana.

The first industry identified, advanced materials, is expected to play an increasingly significant role in the state's economy according to the Louisiana Economic Development Department. Central to the development of a vibrant advanced materials industry is the academic infrastructure for research and development in the field. Louisiana State University, Louisiana Tech University, University of New Orleans, and University of Louisiana – Lafayette have made strategic investments in the formation of academic research centers for advanced materials. The Center for Advanced Microstructures and Devices (CAMD), Center for Rotating Machinery, Center for Turbine Innovation and Investment, and the Louisiana Composites Lab are merely a sampling of LSU's many initiatives committed to research in the area of material and process engineering development.

Furthermore, Louisiana has invested $18 million in the National Center for Advanced Manufacturing (NCAM), which is located in the Michoud Space Center and operated by NASA, Lockheed Martin, and the University of New Orleans. NCAM is regarded as the world's most sophisticated carbon fiber replacement unit. In fact, Michoud was selected by NASA to manufacture and assemble the Crew Launch Vehicle upper stage. This is an integral component in NASA's quest to develop and produce the next generation of space transportation systems. Moreover, one of three Laser Interferometer Gravitational-Wave Observatories (LIGOs) in the nation is located in Livingston, LA. LIGOs produce research on cosmic gravitational waves, which provides priceless insights into the nature of the universe.

According to LED, the agriculture, forestry, and food production and processing industry provides an estimated $13 billion to the Louisiana economy each year, which represents approximately 10 percent of the Louisiana economy (Louisiana Economic Development; 2007). Given the fundamental nature of this industry, it is essential that the state provides vehicles for business development. Central to this undertaking should be collaboration among business, academia, and government leaders.

Due to the 2005 hurricane season and the devastation wrought by Hurricanes Katrina and Rita, Louisiana's construction industry has been identified as a key variable in the state's economic development model. The vast amount of hurricane-affected homes and businesses when coupled with the desperate need for commercial modernization and expansion and infrastructure development, Louisiana is poised to become a leader in construction technology. Opportunities in the area of construction are amplified by Louisiana's $9 billion Road Home program. This program provides $150,000 to eligible homeowners affected by Hurricane Katrina or Rita to repair their homes.

The durable goods industry in Louisiana is composed of several distinct elements: aerospace, aviation, manufacturing, and shipping. As mentioned previously, Louisiana has made several critical investments in the aerospace industry such as New Orleans-based Michoud, the National Center for Advanced Manufacturing, and the Laser Interferometer Gravitational-Wave Observatory in Livingston. In the area of aviation, Louisiana has exhibited strength in the maintenance of rotary and fixed-wing aircrafts. Several aviation-related companies have made infrastructure investments in Louisiana such as Lockheed Martin, EADS, Northrop Grumman, Petroleum Helicopters, Air Logistics, and Vortex Helicopters. In recent years, several aviation

companies such as ASA Air Lines and Continental Express Airlines have either relocated to Louisiana or are undergoing major expansion with an intense focus on Louisiana investment.

Manufacturing has served as a traditional bedrock of the Louisiana economy employing 155,900 individuals in 2003 (*Louisiana: Vision 2020*; 2003). In an effort to advance the state's manufacturing industry, the LED has identified several action items to support and improve long-term business objectives. Various legislative initiatives were targeted to enhance the creation of jobs and retention of workers in the durable goods manufacturing industries. These include: the Louisiana Quality Jobs program, which provides annual rebates for companies creating new, full-time jobs; the Louisiana Opportunity Fund, which provided over $8.5 million for company expansion and relocation; the extension of the sunset date of the Enterprise Zone Tax Credit program, which doubles the standard tax credits for some automotive and airplane manufacturing activities; as well as financial incentives for loan and venture capital programs and the development of workforce training programs (LED; 2007).

Due to specific manufacturing strengths and Louisiana's strategic location, shipbuilding has been identified as an industry of interest. The shipbuilding industry has historically performed well in Louisiana with more than 25 percent of the nation's transport ships being built here. Furthermore, the University of New Orleans (UNO) was rated by the 2000 Princeton Review as having the best naval architecture program in the United States (LED; 2007). UNO houses the Avondale-UNO Maritime Technology Center of Excellence and the Gulf Coast Region Maritime Technology Center, which conducts research in the area of ship design and manufacturing. Louisiana already claims a well-established ship building industry with companies such as Bollinger, Northrop Grumman, Laborde, Trico, Seacor, J. Ray McDermott, Candy Fleet Corp., L&M Brotrus Rental, and Central Gulf Lines.

The oil and gas industry serves as the foundation of Louisiana's economy with an estimated $93 million impact in 2001 (LED; 2007). When offshore operations are included, Louisiana ranks first in the nation in oil production and second in natural gas production. In fact, Louisiana accounts for nearly 27 percent of the nation's daily oil and gas production. Consequently, the oil and gas industry provide a substantial number of jobs for Louisiana citizens. In September 2004 Mid Continent Oil and Gas reported a total of 80 Louisiana members representing 15 refineries and 96,876 employees (LED; 2007). Central to the development of technical innovations in the energy industry has been partnerships between academic and corporate sectors. For example, in 2005 Louisiana State University and Shell Oil Company partnered to establish the Louisiana Oilfield Academy, which awards associates degrees in studies relating to the oil and gas industry. Furthermore, a substantial commitment to research in the field of energy studies can be identified through the formation of LSU's School of Energy Studies, ULL's Energy Institute, and UNO's School of Energy Conservation and Management. Louisiana's infrastructural framework for oil and gas ventures is evident in its 5,000 oil and gas platforms in the Gulf of Mexico, 17 operating crude oil refineries, and 25,000 miles of pipeline for natural gas, crude oil, and refined products. This has resulted in Louisiana boasting the second largest refining capacity (16.9% of total capacity) in the United States.

Louisiana is also home to over 90 chemical plants, making it a major supplier of basic organic and petro chemicals (LED; 2007). Seventy petrochemical manufacturers oversee 100 sites employing 27,000 workers in the state. This has resulted in over 1,000 service companies that report a substantial amount of their business to petrochemical companies. A two-year associate's degree has been developed through the Board of Regents in Petroleum Technology (PTEC). This was the result of a strong partnership between industry and Louisiana technical

colleges. In support of the PTEC program, three “glass labs” were recently built on campuses in Lake Charles, Reserve, and Baton Rouge that will provide students with the infrastructure necessary to experience chemical processes in a classroom setting. Louisiana has also recently identified sustainable energy as an industry of focus. The state currently houses five liquefied natural gas (LNG) facilities with four more proposed or under construction. There has also been a commitment to sustainable energy efforts such as LPG, lignite, biofuel, wind, and greenfield refineries.

Louisiana has recently revalorized its historical entertainment legacy with a unique tax incentive program for film, sound recording, and digital media enterprises. This includes the Film Industry Tax Credit, which provides tax credits for up to 25 percent of film production costs; the Digital Media Tax Credit, which provides a 20 percent tax credit against expenditures in Louisiana for video game developers; and the Sound Recording Tax Credit, which provides a refundable tax credit for up to 20 percent for recording products or infrastructure development.

Louisiana has seen the largest growth in state-wide film activity in the country with an annual employment growth rate of 23 percent per a year and an annual wage increase of approximately 20 percent. In large part due to the passage of the aforementioned incentive packages, the state’s film industry has provided a $400 million economic stimulus since 2002 (LED; 2007). Production costs exceeded $600 million in 2005 and had reached $203 million in May 2006. Louisiana’s local film industry labor union has witnessed a 200 percent increase since 2002, with over 2,000 locals involved in projects and initiatives. Infrastructure and technological development has been key to attracting potential investors. UNO houses the Robert E. Nims Center in Harahan, LA where high definition production suites are being constructed that will accommodate online and offline editing bays, a screening room, and

additional dialogue recording suites. In 2005 alone, Louisiana was the site of production for nearly two dozen feature films and TV movies such as *All the King's Men, Failure to Launch,* and *Big Momma's House 2*.

Digital media industries such as gaming, animation, and digital effects have also been targeted through the aforementioned tax incentive programs. Louisiana has attracted and serves as the home to several leaders in the industry (LED; 2007). Turbosquid is the world's leading supplier of 3-D products for sale with over 158,000 models and textures, software, and tutorials. Nerjyzed is a major developer of 3-D animations and video games, and Yatec is a newly formed video game development company.

Three hundred fifty IT companies are currently located in Louisiana. However, LED has emphasized the need to augment the capacities and fundamental infrastructures in order to foster the growth of in-state technology businesses and attract out-of-state firms. To do this, they have developed an IT strategy that includes the following initiatives: "expand Louisiana's IT companies and improve their bottom-line; improve the capacity of Louisiana's workforce; connect the state's universities, government, and industry for collaboration; and recruit out-of-state IT organizations to locate facilities and jobs in Louisiana" (LED; 2007). To reach these ends, Louisiana has constructed and maintains three IT incubators: the Louisiana Tech Technology Incubator, the Louisiana Technology Incubator for Entrepreneurial Success at the University of Louisiana – Lafayette, and the Louisiana Business and Technology Center. Furthermore, the Louisiana Optical Network Initiative (LONI) was established to connect five supercomputers across the state. LONI enabled the state's Board of Regents to become a member of the National Lambda Rail (NLR). NLR is a nationwide grid computing infrastructure that allows for the transmission of 40 billion bits of data per second. LONI has enabled the

development of such initiatives as the Louisiana Immersive Technology Enterprise, a state-of-the-art advanced visualization facility located in Lafayette, LA, which houses the world's first six-sided, digital virtual reality cube as well as the world's largest digital 3-D auditorium.

The Louisiana Economic Development Department has created a strategic plan that places emphasis on expanding the state's life science industry through strategic investments that target the biotechnology and biomedical areas. The two primary objectives of this strategy are: to "foster a vibrant entrepreneurial culture to support the formation and growth of biotechnology firms in Louisiana" and to "establish a seed capital fund for early stage proof-of-concept and business formation" (LED; 2007). The state has already earmarked $30 million to assist in the development of three regional innovation centers located in Shreveport, Baton Rouge, and New Orleans. These centers are designed to provide low-cost wet lab incubator space and integrated business development services. LED is also in the process of establishing a $45 million Small Business Investment Company fund. Currently operating in the state is the Good Manufacturing Practice laboratory for stem cell research, the Louisiana Cancer research Center of New Orleans, and the Gene Therapy Research Consortium. The Pennington Biomedical Research Center is a state-of-the-art research complex that houses 14 research laboratories, 17 core service laboratories, impatient and outpatient clinics, a research kitchen, and more than $20 million in cutting-edge technologies.

Louisiana possesses one of the most extensive installed logistics infrastructures in North America and has the largest port complex in the world with of six deepwater, eight coastal, and 13 inland facilities. In fact, the Port of South Louisiana is the largest single port in the United States (ranked by Tonnage, 2001, U.S. COE). There are only two sites in the United States, one of which is Louisiana, where all six of North America's Class One railroads converge.

Louisiana also supports six interstate highways and numerous public and private airports that can accommodate any size aircraft. Furthermore, the Louisiana Department of Transportation and Development has organized the Louisiana Investment of Infrastructure for Economic Prosperity Commission, which aims to modernize the Statewide Transportation Plan to accommodate the transportation needs of Louisiana citizens and industry.

The second objective of goal two in *Louisiana: Vision 2020* focuses on increasing public and private R&D expenditures. Louisiana has made a substantial commitment to university-performed R&D; however, Louisiana is weak in federal and industry R&D. Industry-performed research and development accounts for 75% of total R&D expenditures in the nation. In 1999 the dollar amount of research and development per capita conducted in Louisiana, both private and public, was a mere 28 percent of the national average (*Louisiana: Vision 2020*; 2003). *Vision 2020* plans to increase that percentage to reach the national average by 2018. Recognizing that these expenditures are essential in the knowledge economy, the Louisiana legislature passed an R&D tax credit in 2002 in an attempt to encourage investment in university research and the pursuit of research grants and other forms of federal funding for research and development. Central to this objective is the role of Louisiana's universities in partnering with business and industry to leverage current research successes into "industrial research commitments." To reach these goals it is essential that the percentage of recent science and engineering PhDs in the workforce is increased. In 1999, a mere 0.09 percent of the Louisiana workforce was recent science and engineering PhD recipients, in comparison with an average of 0.14 percent nationally (Office of Technology Policy; 1999). The target goal for this benchmark is to reach the current national average by 2023 (*Louisiana: Vision 2020;* 2003). Another valuable indicator of a state's innovative activity is the number of patents issued, which will be

expounded upon in succeeding sections. In 1999 Louisiana generated 54 patents per 10,000 business establishments, while the national average was 134 (Office of Technology Policy; 1999). Louisiana's goal for 2023 is to generate 166 patents per 10,000 business establishments (*Louisiana: Vision 2020*; 2003).

Table 1: Research and development expenditures per capita (percent of national average)

Baseline Data	Current Data	Targets				
		2003	2008	2013	2018	2023
17%	28%	38%	59%	80%	100%	100%

Baseline data – 1994 Source: *Louisiana: Vision 2020*
Current data – 1999

Table 2: Percentage of recent science and engineering PhDs in the Louisiana workforce[2]

Baseline Data	Current Data	Targets				
		2003	2008	2013	2018	2023
.08%	.09%	.10%	.11%	.12%	.13%	.14%

Baseline data – 1997 Source: *Louisiana: Vision 2020*
Current data – 1999

Table 3: Number of patents issued per 10,000 business establishments

Baseline Data	Current Data	Targets				
		2003	2008	2013	2018	2023
46	54	73	96	119	143	166

Baseline data – 1997 Source: *Louisiana: Vision 2020*
Current data – 1999

Also important to any economic development plan is access to capital. Access to capital is integral for the formation of new businesses and the fostering of a vibrant, entrepreneurial culture. In 2002 $109 million in venture capital was reported as invested in Louisiana companies (*National Venture Capital Association Yearbook*; 2001). *Vision 2020* calls for venture capital investments to reach $500 million in Louisiana by 2023. This level of investment is necessary

[2] This table measures the percentage of Louisiana workers who received science and engineering PhDs in 1990-1998. It was calculated by dividing the number of PhD degree holders by the 1999 civilian workforce.

for the development and support of early stage companies, which play an integral role in the Louisiana economy.

Table: 4 Venture capital disbursements

Baseline Data	Current Data	Targets				
		2003	2008	2013	2018	2023
$89.2	$109	$70	$200	$300	$400	$500

Baseline data – 1998
Current data – 2002

Source: *Louisiana: Vision 2020*

With the rise of the knowledge economy and the primacy that economic development has come to play in the mission and vision of the university, commercially driven research has become a crucial pillar in economic development models around the nation, and Louisiana is no different. University technology transfer activities have been identified as crucial for the development of new knowledge, technologies and businesses. Universities offer intellectual capital, intellectual property and specialized facilities that are assets for corporate development (*Louisiana: Vision 2020*; 2003). *Vision 2020* measures the effectiveness of Louisiana universities in developing new technologies by the number of licenses completed in total and as a percentage to Louisiana companies as well as the number of university cooperative endeavor agreements with companies. At the 2003 update, the Louisiana Board of Regents had yet to complete data collection for these two benchmarks.

A thriving economy is necessarily driven by innovative and entrepreneurial companies. Given this maxim, Louisiana has recognized the need to create a pro-entrepreneurship environment that is supported by state laws and tax structures. There are more than 900 business incubators in the nation, with 18 of them located in Louisiana, including three “wet lab” incubators in Shreveport, Baton Rouge and New Orleans. (Louisiana Business Incubator Association) Louisiana’s goal is to have 25 established business incubators in the state by 2023. Several of these should be industry specific incubators to support the aforementioned cluster

development concept (*Louisiana: Vision 2020*; 2003). Another indicator for the level of entrepreneurial activity in a state is the business "churning rate." This measures new firm births and existing firm deaths as a percentage of total firms and is considered an important measure of innovation and growth. Louisiana ranked 40th nationally in 1998 with a business churning rate of 21.9 percent, jumped to 23rd in 2002 at 24.1 percent but dropped back to 41st in 2003 with a rate of 22.7 percent (SBA Office of Advocacy; 2003).

Table 5: Business incubators in Louisiana

Baseline Data	Current Data	Targets				
		2003	2008	2013	2018	2023
16	16	16	18	20	22	25

Baseline data – 1998 Source: *Louisiana: Vision 2020*
Current data – 2003

Table 6: Business churning rate

Baseline Data	Current Data	Targets				
		2003	2008	2013	2018	2023
21.9%	22.7%	24.5%	26%	27.5%	29%	30%

Baseline data – 1998 Source: *Louisiana: Vision 2020*
Current data – 2003

Necessary for the development of an emerging technologies based economy is an I.T. infrastructure that can support companies participating in the global economy. The state currently has extensive fiber optic capabilities; however, these resources are confined to metropolitan areas and rarely extend to the vast non-metropolitan areas of Louisiana. The benchmarks identified for measuring I.T. infrastructure in *Vision 2020* is percentage of households with computers, percentage of households with Internet access and percentage of households with broadband Internet access (*Louisiana: Vision 2020*; 2003). In 2001, 45.7 percent of Louisiana households had at least one computer in the home and 40.2 percent reported Internet access (U.S. Department of Commerce; 2001). *Vision 2020* targets these indicators to be 90 percent and 95 percent respectively by 2023. Also, in 2000 64 percent of Louisiana

households were located within zip codes where high speed internet is available (Federal Communications Commission; 2000). 100 percent of Louisiana households are targeted for broadband Internet service by 2023 (*Louisiana: Vision 2020*; 2003).

Table 7: Percentage of households with computers

Baseline Data	Current Data	Targets				
		2003	2008	2013	2018	2023
41.2%	45.7%	47%	55%	70%	80%	90%

Baseline data – 2000 Source: *Louisiana: Vision 2020*
Current data – 2001

Table 8: Percentage of households with Internet access

Baseline Data	Current Data	Targets				
		2003	2008	2013	2018	2023
30.2%	40.2%	45%	55%	75%	85%	95%

Baseline data – 2000 Source: *Louisiana: Vision 2020*
Current data – 2001

Table 9: Percentage of households with broadband Internet available

Baseline Data	Current Data	Targets				
		2003	2008	2013	2018	2023
57%	64%	80%	100%	100%	100%	100%

Baseline data – 1999 Source: *Louisiana: Vision 2020*
Current data – 2001

The final objective for creating an economy driven by innovative, entrepreneurial and globally competitive companies is the development of an equitable tax structure, regulatory climate and civil justice system. It is a continual challenge to initiate regulatory reforms that recognize the needs of citizens as well as businesses.

One measure of the state's economic climate is its bond rating. The rate for General Obligation Bonds measures perceived investor risk in relation to payment of debt obligations. The lower the state ranks, the higher the cost of outside capital. The availability of low cost

external capital is integral during periods when investor liquidity is low. In 2003 Louisiana was 43rd out of the 45 states ranked (Moody's Investor Services). *Vision 2020* sets a target for Louisiana to be ranked 20th by 2018.

Also important is federal funding flows, both from and to Louisiana. Louisiana provided $19.8 billion in funds to the federal government in 2002, while Louisiana received $29.4 billion in federal assistance. This resulted in a $9.6 billion net gain for the state (Tax Foundation; 2002). These statistics would indicate that Louisiana is doing much better than other states according to this benchmark; however, to reach the aforementioned economic development goals, federal funding must be strategically focused on research, infrastructure and job development rather than the present areas of healthcare and social assistance programs.

Another measure for evaluating how conducive a state is to business development is the Site Selection Magazine's state business climate rankings. The 2003 rankings were based on five criteria: new and expanded corporate facilities for 2001; new and expanded corporate facilities for 1999-2001; new and expanded corporate facilities per a square mile; and responses from Site Selection's annual survey of corporate real estate executives. Based on these criteria, Louisiana ranked 17th in 2003 (Site Selection; 2003). *Vision 2020* targets Louisiana to break the top ten by 2023.

Table 10: State bond rating

Baseline Data		Current Data	Targets				
			2003	2008	2013	2018	2023
Louisiana	**A2**	**A1**	**A1**	**Aa3**	**Aa2**	**Aa2**	**Aa2**
State median	**AA2**	**Aa2**	**Aa2**	**Aa2**	**Aa2**	**Aa2**	**Aa2**
National Ranking	**40**	**43 of 45**	**35**	**30**	**25**	**20**	**20**

Baseline data – 1998
Current data – 2003

Source: *Louisiana: Vision 2020*

Table 11: State business climate ranking

Baseline Data	Current Data	Targets				
		2003	2008	2013	2018	2023
13	17	24	19	15	12	10

Baseline data – 1997 Source: *Louisiana: Vision 2020*
Current date – 2003

Although the impacts of innovative activity and knowledge spillovers have served as a motive for the development of public policy emphasizing the importance of investing in such areas as university research and development, the spatial constructs of knowledge spillovers have yet to be identified nor has the relationship between innovative capacity and per capita income been tested.

The remainder of this paper attempts to provide an overview of the state of Louisiana patent statistics, evaluating the consistency of Louisiana patent production with national averages. In addition, the role of patent production in producing per capita income growth in relation to other variables such as human capital will be analyzed. Finally, conclusions and directions for further research will be given.

State of Louisiana Patent Statistics

Between the years of 1981 and 1995, Louisiana inventors produced 13,288 patents. Given that 728,406 patents were produced in the United States (including the District of Columbia) for the same time period (Hall et al, 2001), Louisiana's share accounts for 1.82 percent of total production. Upon evaluation some marked similarities as well as differences are evident between Louisiana and the national average in relation to the technological structure of patent production. These differences are outlined in Table 12. When divided into the six technological categories defined by Hall, Jaffe and Trajtenberg (2001) - chemical, computers and communications, drugs and medical, electrical and electronic, mechanical and other - several distinct trends are evident.

Louisiana has a higher percentage of patents produced in the chemical and other categories when compared to the national average; however, the state noticeably lags behind in the areas of computers and communications, drugs and medical, electrical and electronic and mechanical. Louisiana has a rich history of infrastructure expansion and invests heavily in research and development in the field of chemical production. As a result, Louisiana rates well above the national average in this area of knowledge stock. These descriptive statistics suggest that over the last decade and a half Louisiana has laid a foundation to be nationally competitive in this area.

Table 12: Patent Production by Technological Category, 1981-1995.

	Chemical (excluding drugs)	Computers & Communications	Drugs & Medical	Electrical & Electronic	Mechanical	Others	Total
Louisiana	4,931	287	733	648	2,286	4,403	13,288
Percent of Total	37.11	2.16	5.52	4.87	17.20	33.14	100.00
United States	136,292	84,761	78,551	118,706	140,016	170,080	728,406
Percent of Total	18.71	11.64	10.78	16.30	19.22	23.35	100.00

Source: Hall et al. 2001.

Louisiana Parishes

Figure 1 illustrates that patent production in Louisiana is spatially concentrated. Upon examination it should be noted that the highest production levels are concentrated in the major metropolitan areas of Baton Rouge, Lafayette, New Orleans and Jefferson parishes with East Baton Rouge parish accounting for over 38 percent of Louisiana patent production alone. Minor concentrations can be found in Caddo, Calcasieu, Ouachita and St. Tammany parishes, all of which are classified as metropolitan areas. In fact, the highest producing non-metropolitan parish in Louisiana only accounts for a minor 1.37 percent of total state production.

To account for population size, Figure 2 illustrates the calculations for the number of patents produced per 100,000 population. This figure further illustrates the influence of metropolitan areas on patent production in that the least prolific patent production areas of the state are non-metropolitan areas most removed from the state's urban centers.

This dichotomy of patent production is further assessed in Table 13, which evaluates the difference in patent production among the top producing metropolitan and non-metropolitan parishes in Louisiana. Metropolitan areas account for over 92.81 percent of total patent production in Louisiana; whereas, these same areas account for only 75.41 percent of the population. These statistics are consistent with findings at the national level which conclude that metropolitan areas account for 92 percent of total patent production (O hUallachain, 1999). Of the non-metropolitan areas in Louisiana, twelve parishes produced less than ten patents during the fifteen year period. Consequently, non-metropolitan patent production accounts for a mere 7.19 percent of total Louisiana production even though it accounts for 24.59 percent of the population.

Table 13: Distribution of Patent Production in Metropolitan and Non-Metropolitan Areas between 1981 and 1995.

	East Baton Rouge Parish	Iberia Parish	Jefferson Parish	Lafayette Parish	Orleans Parish	St. Mary Parish	Metro Total	Non-Metro Total
Patents	5,772	208	1,675	994	1,887	116	14,063	1,089
Patents Per 100,000 Population	129.15	4.65	37.48	22.24	42.22	2.59	314.68	24.36
Percent of State Patents	38.09%	1.37%	11.05%	6.56%	12.45%	0.77%	92.81%	7.19%
Percent of State Population	9.24%	1.64%	10.19%	4.26%	10.85%	1.20%	75.41%	24.59%

Source: Hall et al. 2001.

Furthermore, when considering metropolitan patent production in Louisiana, a further bifurcation is evident. East Baton Rouge parish accounts for over one third of the total patents

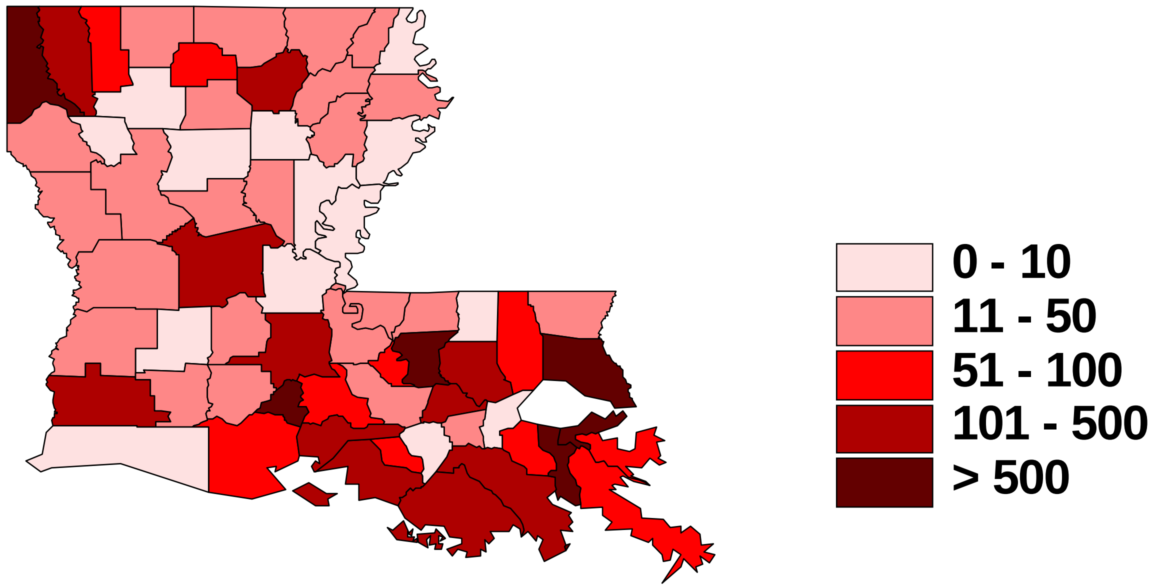
produced in Louisiana and dwarfs patent production in all other metropolitan parishes with the second highest producing parish, Orleans, only accounting for 12.45 percent of total production[3]. Moreover, the proportion of East Baton Rouge parish patent production is more than four times its proportion of the state population. Jefferson and Orleans parishes' proportion of patent production is slightly above their respective proportions of the state population. It is important to note that the two parishes with the highest levels of patent production that are classified as non-metropolitan still do not produce a proportion of patents congruent with their proportion of population.

Patent citations are considered one measure of the quality of a patent (Harhoff et al 1999). When evaluating the number of patent citations received by parishes for patents produced locally, a level of equality surfaces between metropolitan and non-metropolitan parishes that was not before evident. This is illustrated in Figure 3, which shows the average citations received per patent for each parish between 1981 and 1995. As the figure illustrates, there is a greater variation in the citations per patent across parishes. In fact, 3 of the 4 parishes with the greatest average citations per patent are non-metropolitan (Caldwell, Cameron and DeSoto parishes).

There are several possible explanations for this discrepancy. In metropolitan areas, a larger percentage of patents are assigned to corporations than in non-metropolitan areas. Given the highly competitive nature of research and development, many corporations patent potential innovations before they are assessed for their commercial value. Some of these innovations prove to be of little or no value, failing to receive a single citation. Many larger corporations also have access to patent attorneys that are essential in expediting the application process and,

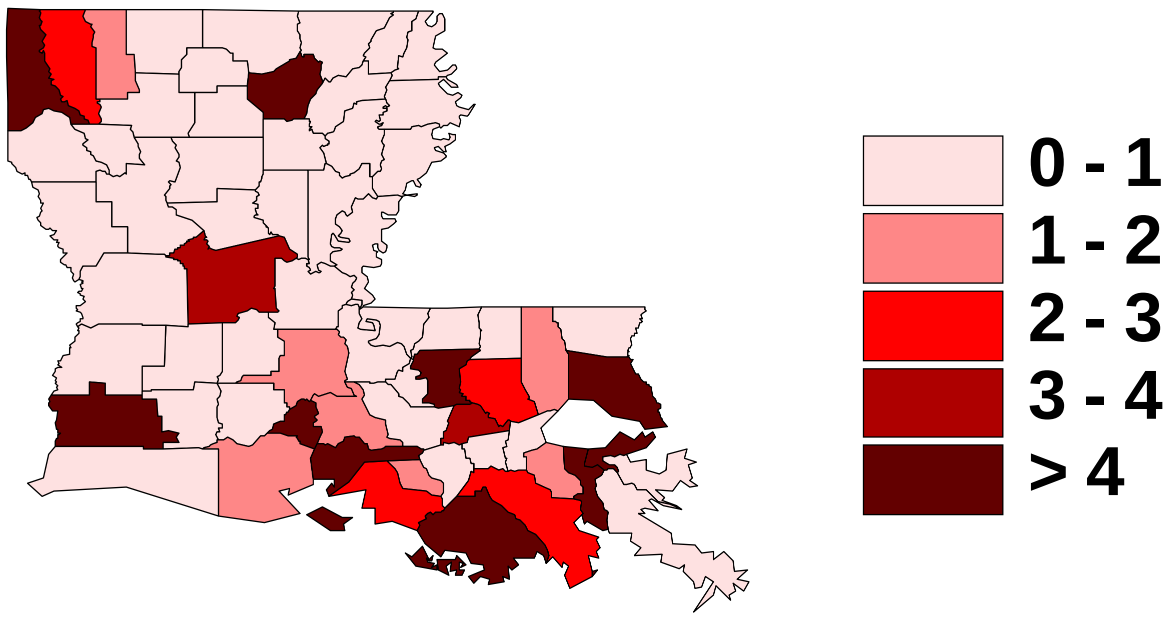
[3] For the purposes of this study, patents were geographically identified with the home address of the first inventor listed on the patent application. Therefore, if the patented innovation was created at the work location of the inventor that was located in a different parish than the parish of residence of the inventor, the descriptive statistics would not pick up this anomaly. Such an anomaly might downward skew Orleans parish patent statistics.

Figure 1: Distribution of Louisiana Patents, 1981-1995.



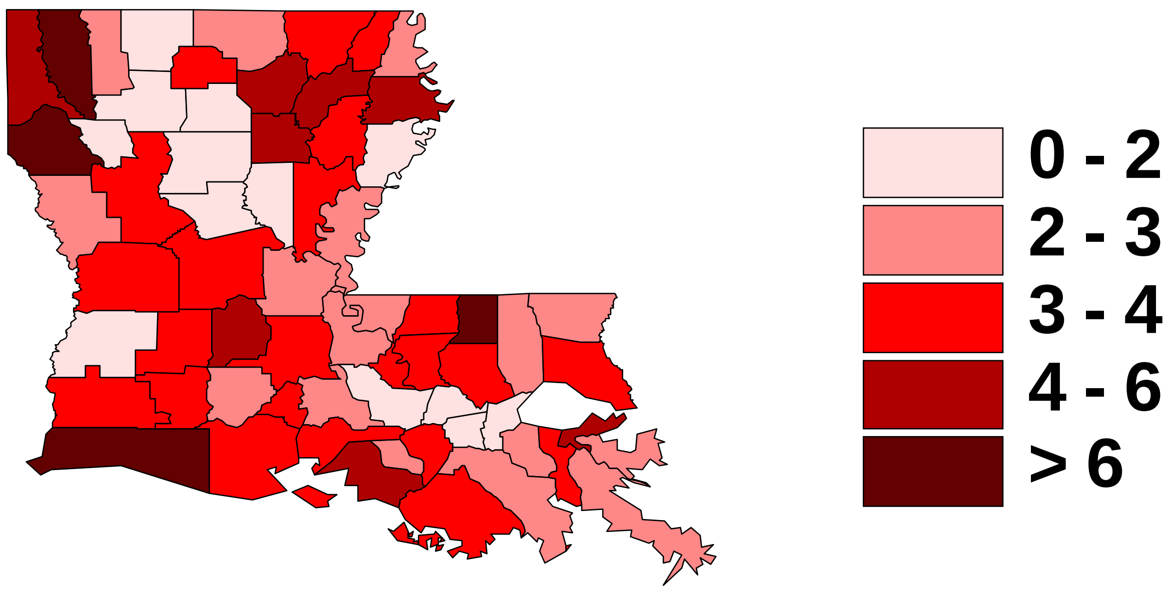
Source: Hall et al. 2001.

Figure 2: Distribution of Patents Per 100,000 Population, 1981-1995.



Source: Hall et al 2001.

Figure 3: Distribution of Citations Per Patent, 1981-1995.



Source: Hall et al. 2001.

given the sheer number of patents produced, the associated costs are spread across multiple patent applications. Patents produced in non-metropolitan areas are more likely to be assigned to individuals or smaller corporations who must evaluate and weigh the benefits of patent production versus the transaction costs of completing patent applications. This cost-benefit analysis may result in fewer non-valuable innovations undergoing the patent application process. As a result, patents originating in non-metropolitan areas may average more citations than their metropolitan counterparts.

Unassigned Louisiana Patents

During the application process, an inventor may choose to assign ownership of the patent rights to a particular entity such as another individual, a university, a corporation, the government, or a non-profit. Patents that are unassigned at application may be those that are being commercialized by the inventors themselves and may be a proxy for new entrepreneurial activity. When comparing the percentage of unassigned patents produced in metropolitan versus non-metropolitan areas of the state, a further dichotomy is evident. Unassigned patents account for 28.25 percent of total patent production in Louisiana while assigned patents account for 71.75 percent. Furthermore, 55 percent of the patents produced in non-metropolitan parishes are classified as unassigned as compared to 26.18 percent in metropolitan parishes. More tellingly, patents produced in non-metropolitan parishes only account for a mere 4.51 percent of total assigned patents.

As Table 14 illustrates, in the two highest patent producing Louisiana parishes, East Baton Rouge and Orleans, 90.54 percent and 71.01 percent of patents produced have been assigned. This should be considered in relation to the two highest patent producing non-metropolitan Louisiana parishes, Iberia and St. Mary, where only 53.85 percent and 42.24

percent of patents produced are assigned. From this analysis, a general trend can be seen that as the total level of patent production in a non-metropolitan parish decreases, the percentage of patents that are unassigned increases. Furthermore, assigned patents produced in non-metropolitan areas only account for 3.23 percent of total patents produced in Louisiana; whereas, assigned patents produced in metropolitan areas account for 68.52 percent of total Louisiana production.

Table 14: Distribution of Assigned and Unassigned Patent Production in Metropolitan and Non-metropolitan Areas between 1981 and 1995.

	East Baton Rouge Parish	Iberia Parish	Jefferson Parish	Lafayette Parish	Orleans Parish	St. Mary Parish	Metro Total	Non-Metro Total
Patents	5,772	208	1,675	994	1,887	116	14,063	1,089
Unassigned Patents	546	96	711	428	547	67	3,682	599
Percent of Total Patents	9.46%	46.15%	42.45%	43.06%	28.99%	57.76%	24.30%	3.95%
Assigned Patents	5,226	112	964	566	1,340	49	10,381	490
Percent of Total Patents	90.54%	53.85%	57.55%	56.94%	71.01%	42.24%	68.52%	3.23%

Source: Hall et al. 2001.

<u>Patent Production and Per Capita Income Growth</u>

Now that an overview of the state of patent production in Louisiana has been summarized, it is essential from a policy perspective to define the effect that this type of patent production has on economic growth. This paper limits its scope to analyzing innovation impacts on economic growth through changes in per capita income. It is important to recognize that it is not the author’s attempt to account for and control every identifiable variable, but rather to use a parsimonious model that focuses upon the broader connection between innovative capacity and economic growth.

Empirically, it is estimated that a simple growth convergence model will result. Convergence refers to the phenomenon of how countries starting with a lower GDP tend to grow faster than countries starting with a higher GDP (Jones, 2002). Traditional convergence models exhibit a strong negative relationship between a country's initial per capita GDP and the country's growth rate, with relatively rich countries growing more slowly while relatively poor countries grow more rapidly.[4]

In order to test this hypothesis, it was important to classify a suitable identifier of innovative capacity. It is widely accepted that local patent production serves as a good proxy for a region's innovative capacity. In addition to the importance of patenting activity, it is recognized that human capital (educational attainment) may also have an effect on economic activity (Mankiw, Romer and Weil, 1992). The data used in the regressions encompass all counties in the United States. The dependent variable, Per Capita Income Growth 1980-1999, represents the overall growth in real income per capita for U.S. counties between the years of 1980 to 1999.[5]

Three independent variables were tested in the regressions. The natural log of per capita income in 1980 was included to control for initial income levels as well as to examine whether there is evidence of convergence in county-level per capita income. Percent Bachelors Degree or Higher refers to the percent of residents in a county with at least a college degree in 1980. This variable should serve as an indicator of a county's stock of human capital at the beginning of the

[4] However, the convergence hypothesis rests upon the assumption that, for industrialized countries, their economies have similar technology levels, investment rates and population growth rates (Jones, 2002). Given that this assumption is not always accurate, the neoclassical growth model serves to predict that if countries have the same "steady state," then the convergence hypothesis holds true. This has led to important new research such as Romer's new growth theory (Romer, 1990; Romer, 1994), which aims to explain not only the lack of convergence in per capita incomes across countries but also to develop a formal macroeconomic theory that explains stylized facts that appear in the economy. This research has led to important changes as to how knowledge production is considered in macroeconomic theory.

[5] Real income was calculated based on adjusting nominal income by the U.S. Consumer Price Index (1982-84=100).

time period and is expected to have a positive effect on per capita income. Lastly, 10 Year Patent Stock refers to the total number of patents granted to inventors in the county from 1971-1980. This variable measures the level of knowledge stock at the beginning of the growth period. Since patents are among the most cited measures of innovative capacity, they are expected to have a positive effect on per capita income. Datasets were obtained from the Bureau of Economic Analysis, U.S. Census, and NBER National Patent Citations Data File (Hall et al, 2001).

Descriptive statistics on both the dependent and independent variables are provided in Table 15. It's important to recognize that 10 Year Patent Stock has a range of 19,511 with a mean of 151.48. Percent Bachelors Degree or Higher has a range of 47.80 with a mean of 11.39. Per Capita Income Growth and ln 1980 Per Capita Income Growth both exhibit complementary ranges and standards of deviation.

Table 15: Descriptive Statistics for Dependant and Independent Variables.

	Obs.	Mean	Std. Dev.	Min	Max
Dependent Variable: Per Capita Income Growth 1980-99	3,073	1.3530	0.2323	0.3920	3.5508
ln 1980 Per Capita Income	3,073	9.1742	0.2311	7.9913	10.1631
% Bachelors Degree or Higher	3,073	11.3882	5.3168	0	47.8000
10 Year Patent Stock	3,073	151.4849	757.6240	0	19,511

<u>**Regression Results and Analysis**</u>

The findings of the regression analysis are presented in Tables 16 (all counties) and 17 (comparison of metro and non-metro counties). In the per capita income growth regressions, ln

1980 Per Capita Income, % Bachelors Degree or Higher, and 10 Year Patent Stock are included both individually and in combination. Several patterns are evident from the results.

According to conditional convergence theory and our supposition that measures of innovative capacity are essential in explaining income growth, negative signs on the initial income levels and positive coefficients on the remaining variables were expected. The resultant statistics from ln 1980 Per Capita Income are congruent with the hypothesized simple growth convergence model. Those counties with a lower per capita income in 1980 saw higher growth rates over the twenty year period measured than those counties starting with higher per capita incomes. A noteworthy observance relating to this variable is the difference in magnitude between metropolitan and non-metropolitan counties. These statistics illustrate that between 1980 and 1999, non-metro counties having higher per capita incomes grew slower than metro counties exhibiting the same level of income. Likewise, non-metro counties having lower per capita incomes grew faster than their metropolitan counterparts.

A strong positive relationship was found between educational attainment and earnings; therefore, the results would suggest that counties with more college graduates had higher per capita income growth rates. These regressions indicate that human capital as a measure of innovative capacity is a very important determinant of per capita income levels for both metro and non-metro areas, which is illustrated in the level of consistency in sign and significance across both metro and non-metro areas.

Surprisingly, 10 Year Patent Stock did not have a statistically significant impact on per capita income in non-metropolitan counties, and only a very minute, significant impact in metropolitan counties and counties as a whole. One important point that has surfaced through this analysis is that metropolitan counties are typically more successful in converting knowledge

stock into per capita income through commercialization and innovation than their non-metropolitan counterparts.

Table 16: Innovative Capacity on Per Capita Income Growth.

Dep Variable: Per Capita Income Impact on Growth 1980-99	All Counties	All Counties	All Counties
ln 1980 Per Capita Income	-0.44 (0.00)	-0.63 (0.00)	-0.66 (0.00)
% Bachelors Degree or Higher		0.02 (0.00)	0.01 (0.00)
10 Year Patent Stock			4.21E-05 (0.01)
Constant	5.37 (0.00)	6.95 (0.00)	7.20 (0.00)
Obs. R-square	3,073 0.1902	3,073 0.2756	3,073 0.2922

P-values in parentheses

Table 17: Metro vs. Non-Metro Impacts of Innovative Capacity on Per Capita Income Growth.

Dep Variable: Per Capita Income Growth 1980-99	Non-Metro Counties	Non-Metro Counties	Non-Metro Counties	Metro Counties	Metro Counties	Metro Counties
ln 1980 Per Capita Income	-0.68 (0.00)	-0.78 (0.00)	-0.79 (0.00)	-0.13 (0.00)	-0.33 (0.00)	-0.37 (0.00)
% Bachelors Degree or Higher		0.01 (0.00)	0.01 (0.00)		0.01 (0.00)	0.01 (0.00)
10 Year Patent Stock			8.28E-05 (0.11)			1.83E-05 (0.00)
Constant	7.56 (0.00)	8.36 (0.00)	8.39 (0.00)	2.56 (0.00)	4.31 (0.00)	4.65 (0.00)
Obs. R-square	2,020 0.3518	2,020 0.3870	2,020 0.3878	1,053 0.0231	1,053 0.1119	1,053 0.1262

P-values in parentheses

Conclusions

Although this was a national study, it is necessary to recognize that important policy implications can be drawn for states such as Louisiana. It was shown that Louisiana is largely

consistent with national averages in both distribution of patent activity among metro and non-metro areas as well as across technological categories. According to the preliminary results presented in this paper, it is vital that policy makers take into account that although both educational attainment and patent stock were both positive and significant, returns on educational attainment are much higher, especially in non-metropolitan areas.

Louisiana's aforementioned economic development model chooses to spread public resources and investment across several distinct industrial clusters without taking into account geographic proximity of projects proposed nor the current knowledge foundation of the industry. In order to spur sustained economic growth it will be necessary for Louisiana policymakers to refine their objectives of development to a few industries that have, over the last decade and a half, laid a foundation to be nationally competitive. Louisiana has a rich history of infrastructure expansion and has invested heavily in research and development in the fields of chemical and mechanical patent production. As a result, Louisiana rates well above the national average in this area of knowledge stock. Accordingly, these areas should be considered prime candidates for continued investment and infrastructure development.

Investment in historically significant industries does not preclude investment in technologically driven industries. However, policymakers must not blindly accept the supposition that knowledge production plays a significant role in driving economic growth. Investment in these activities should be targeted and strategic. In light of Barkley and Henry's (2006) conclusions concerning the minimal levels of knowledge spillovers from the metropolitan epicenters where investment occurs to the surrounding non-metropolitan areas, it is necessary that centers of investment within these knowledge driven industries be spatially proximate.

Furthermore, the benefits of using knowledge production as an economic development tools must be critically analyzed in relation to other economic development strategies employed by states. Policy imperatives that provide the mechanisms for the production of new knowledge and the commercialization of that knowledge, which leads to the production of new jobs, is central to the conceptualization of knowledge production as a catalyst for economic growth. This strategy ultimately focuses on the production of physical inputs that are then transformed into commercial products and produced locally (Fannin, 2003). An alternative strategy was the impetus for Richard Florida's book "The Rise of the Creative Class" (2002), which focuses on labor inputs rather than physical inputs. Florida argues that "creative class" workers choose among alternative geographic locations for employment based more on amenities and lifestyle factors than salary and employee benefits. This development strategy would suggest policy initiatives that provide the physical amenities necessary to attract a "creative class" labor force.

Direct purchasing is another strategy than can be employed for economic development (Fannin, 2003). According to this strategy, public policy serves as a negotiating force that seeks to attract firms to establish production in a certain location, resulting in a substantial increase in jobs in that region. The elimination of certain business taxes as well as direct subsidies are examples of incentives employed to attract firms and create jobs. A prime example of this strategy is Louisiana's tax incentive program for film, sound recording, and digital media enterprises. Also exhibited by this program are the inherent administrative pitfalls of such an extensive initiative.

Each of these strategies has its advantages and disadvantages. Two disadvantages of the physical input strategy is that there is no direct way to relate public policy initiatives to jobs created and the fact that this strategy is for the most part limited to areas that contain a larger

proportion of highly educated labor (Fannin, 2003). However, a major advantage of the physical input strategy is its application to small business. Unlike the direct purchasing strategy, which for the most part is focused toward large firms that produce a substantial number of jobs, the commercialization of regional knowledge often results in new firm spin-offs and startup companies. Direct purchasing on the other hand often results in the establishment of a large firm for a limited number of years before it moves to another area with a more enticing tax incentive and subsidy package (Fannin, 2003).

The biggest disadvantage of the labor input strategy is the noticeable lag that occurs from the time of investment in local amenities to the recognition of this investment by "creative class" employees. Another considerable lag may also occur between the attraction of a "creative class" labor force and the re-location of firms to employ that labor force (Fannin, 2003).

After comparing the advantages and disadvantages of these development strategies in relation to the regression analysis and results, it is arguable that the physical input strategy would provide the greatest returns for regional economic development only if focused on industries that have a historical foundation in knowledge production and strategic investment in technology driven industries that are spatially proximate. Policymakers must not forget the pervasive role that educational attainment plays in each of these strategies. As was stated earlier, educational attainment has a statistically greater affect on per capita income nationally than knowledge stock. Any economic development strategy must take into account strategic investment in universities both as a precursor to producing an educated workforce that attracts business as well as a mechanism for corporate and community partnerships in the production of knowledge.

It should be recognized, however, that the variables considered in this paper are not the only possible determinants of economic growth. Given the parsimonious model used in this

study, it is necessary that many other factors should be tested as well. In his explanation of conditional convergence, Jones (2002; p. 63-71) provides a wealth of factors that could have an overall effect on per capita income. However, this paper does question the often times blind acceptance of the role that patent production plays in driving economic growth. Hence, further research should add additional control variables to the analysis. A comprehensive understanding of the role that knowledge stocks have on economic growth will require more rigorous analysis that incorporates variables that measure such linkages as the role of strategic investment in research and development in metropolitan areas. It is also important to understand the resultant effect on non-metro areas as well as the role that unassigned patents play in subsequent knowledge production and their effects on rural communities.

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