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SCIENCE AND TECHNOLOGY INDICATORS IN EPSCoR STATES

A POLICY GEOGRAPHY

A dissertation

Presented to

The School of Graduate Studies

Department of Geography, Geology and Anthropology

Indiana State University

Terre Haute, Indiana

In Partial Fulfillment

of the Requirements for the Degree

Doctor of Philosophy

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by

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May 2009

SCHOOL OF GRADUATE STUDIES
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CERTIFICATE OF APPROVAL

DOCTORAL DISSERTATION

This is to certify that the Doctoral Dissertation of

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entitled

Science and Technology Indicators in EPSCoR States: A Policy Geography

has been approved by the Examining Committee for the dissertation requirement for the

Doctor of Philosophy degree

in Geography

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ABSTRACT

In recent year's science and technology-based economic development has been well recognized. Technology-based development has been recognized as dependent upon research and development, presence of diverse metropolitan areas, sophisticated workforce and presence of strong research universities collectively fueling local economic development. As such local and regional economic developments even in lagging states have come to recognize the significance of the triple helix model. This study examines spatial attributes for major science and technology indicators in states recognized as National Science Foundation participants in the Experimental Program to Stimulate Competitive Research (EPSCoR). The objective is to determine the patterns of change among the science and technology indicators in EPSCoR states relative to nationwide trends using correlation, regression and shift-share analysis. The principal conclusion of this study is in the form of a hypothesis proved that (i) EPSCoR program has made little difference in bringing about technology-based economic development in EPSCoR states as measured by key indicators, and (ii) the gap between EPSCoR and Non-EPSCoR states has continued to widen resulting in a more uneven geography.

Key Words: EPSCoR, National Science Foundation, Policy Geography, Science and Technology, Shift-Share Analysis

ACKNOWLEDGMENTS

I acknowledge with gratitude the advice, encouragement and assistance of several individuals that have been integral to the completion of this dissertation. First and foremost, I am grateful to my advisor Dr. Jay D. Gatrell whose mentoring, rigorous engagement with my ideas, and deep interest in the work facilitated its completion. Dr. Gatrell's continued interest has led to significant improvements in both methodology and perspective. In particular, I wish to thank members of my advisory committee Professor Steven Pontius, Professor John Conant, Dr. Gregory Bierly and Dr. Ryan Jensen for their suggestions to improve the research questions and objectives while displaying an interest in my intellectual development and for reading and commenting on my dissertation proposal as well as the final draft.

I would like to express my deep indebtedness to Professor Larry Brown, Ohio State University and Professor Paul Robbins, University of Arizona for stimulating discussions and encouragement in the winter of 2002 in India which led to the beginning of my journey as a graduate student in the US. I am also grateful to my graduate advisor Dr. Ashok Dutt, Professor Emeritus, University of Akron for an abundance of mentoring, intellectual exchange, encouraging feedbacks and collegiality throughout my graduate studies.

I am deeply grateful to my advisor once again who was very kind in offering me graduate assistantship under the National Science Foundation Robert Noyce Scholarship Program (Gatrell, PI) that allowed me to continue my graduate studies at Indiana State University. Thanks are also due to my colleagues Professor Glenn Sebastian, Professor Lary Dilsaver, Dr. Mimi Fearn and Dr. Carol Sawyer at the University of South Alabama who have stood by me supporting my research endeavors and absence from the classroom.

I reserve special thanks for my wife Madhuri, a graduate student at the Ohio State University for enduring my long absence, and for being a source of encouragement and insightful criticism. She also read a full draft and told me of the many places where I had not made things clear; I hope I have been able to improve them. Finally, I dedicate this study to my parents whose constant inspiration, encouragement and support continues to assist me. They prepared me for an academic career in complimentary ways. A mother who taught that in the production of knowledge one must abandon pride for humility and a father who himself as a geographer wanted me to discover the potential of thinking geographically.

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CHAPTER 1

INTRODUCTION

1.1 Background

As economic development was reconceived in the United States in the 1980s, it subsequently witnessed deindustrialization and lay-offs, restructuring in its methods of production and the emergence of new manufacturing and service sectors. The notion of innovation became pivotal in regional economic development. Today, the literature on economic geography broadly and regional economic development specifically, has grown to include a variety of theoretical and empirical works wrapped around overlapping and related concepts of local economic development, innovation, knowledge or learning region, new industrial spaces, technology-based development, knowledge spillovers, new economy, corporate complexes, social capital and embeddedness to name a few (Acs 2002; Acs *et al* 1998; Acs and Varga 2002; Audretsch and Feldman 1994, 1999; Feldman and Florida 1994; Florida 1995, 1997, 2002; Malecki 1991; Porter 1990, 1996, 2000; Scott 1992). These labels are significant as they provide an understanding of some dimension of contemporary regional economic development activity. However, as the economy is reconceived the contemporary economic geography literature has seen the emergence of a dominant theme in the interaction of regions and economic processes, namely, science and technology (SandT) planning. In this study I draw on this new SandT thought within economic geography to analyze local economic development in the Experimental Program to Stimulate Competitive Research (EPSCoR) states.

1.2 Research Problem

In conceptualizing the interaction of regions with economic processes, a key question is that of local dependence or the politics of local economic development as it has evolved in the works of Cox and Mair (1988, 1991). Much research on this interaction of regions and economic processes finds its location problematic as empirical research is situated at the local and regional scale. While the significance of SandT planning-based economic development has been well established in recent years (Acs 2002; Calzonetti 2006; Calzonetti *et al*, 1999; Calzonetti and Gatrell 2004, 2000; Gatrell 1999, 2002; Gatrell and Calzonetti 2004; Gatrell and Ceh 2003; Malecki 1991; Plosila 2004) the concept of clustering and agglomeration-based regional economic development has found much emphasis. Much of this literature in economic geography has to do with success stories of cluster-based economic development in places like Silicon Valley (California), Research Triangle Park (North Carolina), Route 128 Boston (Massachusetts) which suggests that the nature of innovation broadly and economic development is changing (Polenske 2007). While the notion of science and technology-based economic development efforts is as old as the 1960s, it was only in the 1980s that close integration between state science and technology and economic development practice and planning began in a big way (Gatrell and Calzonetti 2004; Plosila 2004). While economic geographers disagree with many aspects of state science and technology and economic development practice and planning with economists, analysts and policy planners, they all seem to agree upon the fact that science and technology indicators remain drivers of economic development for all regions particularly under the impact of global economic restructuring processes (Calzonetti *et al*, 1999; Calzonetti and Gatrell 2000 and 2004; Gatrell 1999 and 2002; Gatrell and Calzonetti 2004; Polenske 2007). While enough has been said about state science and technology and economic development practice and planning by economists, analysts and policy planners, there exists a very thin body of literature by economic geographers in particular (Calzonetti 2006; Calzonetti *et al*, 1999; Calzonetti and Gatrell 2000, 2004; Gatrell 1999, 2002; Gatrell and Calzonetti 2004; Gatrell and Ceh 2003).

At the outset these writings do not clarify the meaning of science and technology; neither do they have a clear framework of definition. Thus, the lay reader tends to use science and technology loosely along with other concepts such as research and development (RandD), innovations and high technology. This in itself presents many thematic and conceptual problems. Most of the empirical studies are still in the nascent stage of conceptual and paradigmatic rigor, particularly those done by economic geographers for they tend to be aspatial. When it comes to measurement, wherever it is done, researchers tend to use relatively simplistic measures of merely trying to find out the amount of innovation, or patents or such other unidimensional measures in a place. Moreover, the study of science and technology-based economic development practice and planning requires periodic examination of science and technology indicators to identify spatial trends and developments, current emphases and future directions. In other words, those studies, though few in number focus less on any understanding of the internal processes that seem to govern the existence of these science and technology indicators in different states or regions and how they play in with the politics of scale and the dynamics of local economic development. Thus, there is a gap in the literature. In all this a better appreciation of SandT thought in economic geography can only be obtained through the evolution of an understanding of the dynamics of spatial variations of science and technology indicators and the processes that determine them, as well as their interaction with other socio-demographic changes, as they occur in specific places (Massey 1984, 1991 and 1993).

1.3 Purpose and Significance of Study

While some states have demonstrated their growth as a technology-based economy (multimedia, biotechnology, healthcare and other medical technologies) many others continue to lag behind. The development of any state as a technology-based economy is dependent on factors such as research and development industry, diverse metropolitan areas, sophisticated workforce, local sources of capital and strong research universities that are the springboards of SandT development. In all this SandT indicators have become significant as a result of the impact of globalization upon local and regional economic development in the form of deindustrialization, reindustrialization and the information age in places (Gatrell 1999). Concomitant with this is its policy implication that technology-based economic development depends upon federal and state support in the form of grants, tax breaks, property rights, etc. It is within this broad framework that this study investigates the spatial dynamics of science and technology (SandT) indicators and its interaction with politics of local economic development and politics of scale. This study demonstrates that the notion of local economic development intersects with the triple helix model in the EPSCoR states to explain what might be happening to the SandT indicators. This study differs from previous works as it attempts to situate the investigation of the changing nature of SandT indicators while considering the implications of targeted SandT initiatives such as the Experimental Program to Stimulate Competitive Research within the theoretical notion of 'local dependency' and the more applied innovation-based economic development literatures (Cox and Mair 1988). This study is important because not only does it empirically map and measure SandT indicator at the state level, but it also explores local processes that drive technology-based economic development in places. This is important for the SandT indicators as through an analysis of high and low performing states the implications for EPSCoR states can be better understood.

This study shall make several contributions to economic geography and public policy and the interdisciplinary literature on regional economic development. Conceptually, it will expand the literature on local and regional innovation process by engaging in an applied economic development literature. Empirically, it maps and measures SandT indicators. Moreover, this study fills in a major research gap in economic geography by (1) expanding a limited library of geographic research on SandT indicators and thus bringing geography to the core and not keeping it to the periphery, and (2) investigating under studied peripheral states called the EPSCoR states.

1.4 Hypotheses

The following hypotheses are proposed:

1. Technology-based economic development in EPSCoR states as measured by key indicators is associated with EPSCoR program.
2. The gap between technology haves (Non-EPSCoR states) and have not (EPSCoR states) states has widened resulting in a more uneven geography.

1.5 Objectives

1. Examine spatial distribution of SandT indicators across states and land grant institutions and how their uneven distribution complicates SANDT planning.
2. Mapping and analyzing metrics of SandT, particularly the gap if any, between input SandT metrics (expenditures) and output SandT metrics (patents, ph.d's etc).
3. Determine implications of geographically targeted SandT initiatives such as the EPSCoR in selected states.

1.6 Study Area

Experimental Program to Stimulate Competitive Research (EPSCoR) States is those states in the US which has evolved into a program that fosters science-based economic development. EPSCoR program was launched by the Congress in 1979 and established by the National Science Foundation (NSF) initially with the aim of fostering scientific competitiveness in states that had not historically won many federal research dollars (Hauger 2004). Currently, there are 27 jurisdictions (Fig. 1) including the Commonwealth of Puerto Rico and the territory of the Virgin Islands that participate in the EPSCoR program. The current focus of EPSCoR program has shifted to include science and technology-based economic development in participating states.

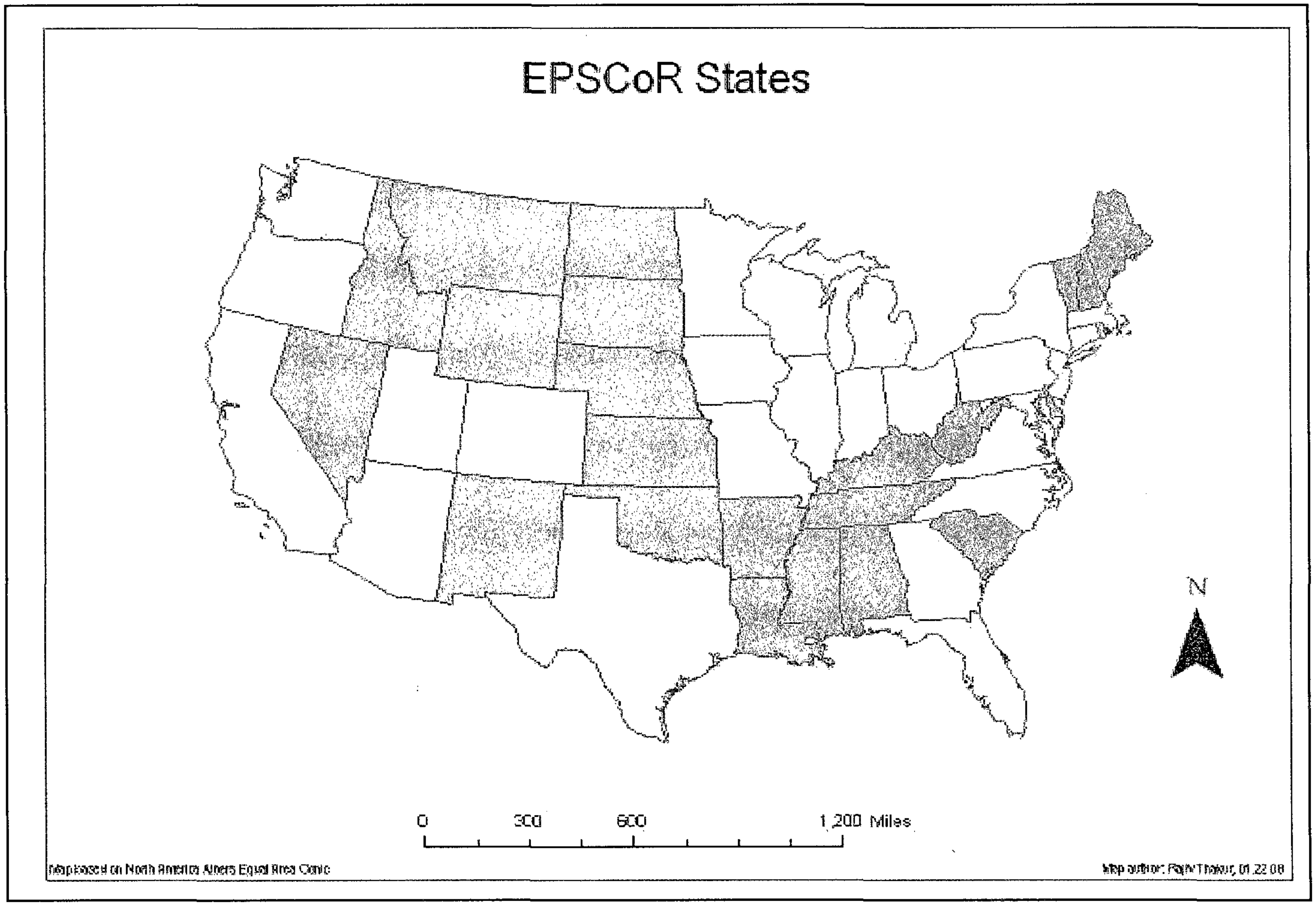

Figure 1.1: Map of EPSCoR states

1.7 Structure of the Dissertation

This dissertation consists of seven chapters.

Chapter 2 reviews contemporary literature on three interrelated themes, strategic science and technology planning, spatialized public policy, and politics of scale.

Chapter 3 presents a history of EPSCoR. In doing so, it brings up a discussion on the implementation and amendment of EPSCoR program, and thereafter presents trends in science and technology planning during the last four decades (1960s till date). This chapter ends with a brief discussion of West Virginia's EPSCoR experience.

Chapter 4 discusses the data and methodology employed in the current research. It begins with a brief discussion on the rationale of the use of data units, provides description of variables used in the study, and explains the rationale of different methods such as ranking analysis, correlations and regression analysis, and shift-share analysis.

Chapter 5 examines the spatial distribution of science and technology indicators at both scales, All-States and Land Grant Institutions (LGIs). In doing so, it uses methods such as the Ranking, Pearson Correlations, Regressions, and Shift-Share analyses for all-states, EPSCoR states, non-EPSCOR states, All-LGIs, EPSCoR LGIs, and non-EPSCoR LGIs. It also discusses and presents the final regression models, and the shift-share analysis. It ends with a discussion and presentation of limitations for the current research.

Chapter 6 briefly discusses the spatialized policy implications of EPSCoR initiatives as it unfurls through the program's historical examination and empirical findings. Chapter 7 highlights the major conclusions and makes suggestions for future research.

CHAPTER 2

LITERATURE REVIEW

2.1 Background

Contemporary literature on science and technology-based economic development displays two special tendencies: (1) it places a premium on empirical research directed at conceptual themes such as local economic development, politics of scale etc. and (2) it seeks comparisons at different scales, such as inter-regional within a country or inter-locality within a region.

From an economic development perspective the significance of SandT indicators lies in the fact that ultimately they help create new jobs, as such SandT indicators are seen as drivers for economic development and a quantitative representation of qualitative concepts, such as local economic development, technology clusters, knowledge or learning regions. SandT indicators statistically articulate descriptive as well as normative aspects of theoretical formulations at the interface of local economic development and politics of scale. Thus SandT indicators give an operational meaning to the idea of technology-based economic development.

Following this brief introduction, this research reviews three interrelated themes. Firstly, a brief but detailed review of the literature on strategic SandT planning is carried out to understand how they have been deployed in empirical studies. Secondly, recent work on spatialized public policy is discussed and, finally, we consider the literature on politics of scale to understand the different approaches. These three interrelated themes together provide the conceptual underpinnings of this dissertation.

2.2 Strategic Science and Technology Planning

In 1990, Porter's Competitive Advantage of Nations established a new thought process in the wake of global economic restructuring. It evoked the idea that technology and competitive strategy have come to challenge the traditional significance of location as understood popularly. Porter's work provoked a new research agenda among those who were interested in economic processes and regional development (Adams and Jaffe 1996; Audretsch and Feldman 1994, 1996, 1999; Cooke 2002; Feldman and Florida 1994; Florida 1995, 1997, 2002; Malecki 1991; Porter 1990, 1996, 2000). Technology-based economic development came to be recognized as important to our regional and national economies, since science and technology indicators (such as academic RandD, employment in high-technology establishments as share of total employment, industry performed RandD as share of private industry output, net high-technology business formations as share of all business establishments, RandD as share of GSP, and venture capital deals) came to contribute to technology-based economic development. In so much, strategic science and technology planning became desirable. In much of the work that followed, clusters and agglomerations came to have significance as against location.

Conceptually, this literature review begins with a brief clarification of what constitutes science and technology. Secondly, this review positions the rather scant literature on strategic science and technology planning within the theoretical context of economic restructuring and finally, it provides an overview of empirical research on related issues, such as the role of universities and indicators in the observed geography of science and technology.

In the literature on economic processes and strategic regional development planning, nowhere has science and technology been defined. Since this study undertakes the task of studying science and technology indicators, a precise definition is warranted. National Science Foundation's (NSF) indicator-based explanation of SandT is a rather consumption-based understanding. This notion of SandT is also written large in any SandT reports that emerge from a federal institution. Conceptually, the notion of SandT seems to move from academic circles and policy makers and back without deep thoughts about its meaning. The closest that researchers have come is to talk around its indicators using the National Science Foundation data on Science and Engineering indicators. Much research by economic geographers regards research and development as a subset of science and technology. There has never been an attempt to distinguish RandD activities from the science and technology activities (Fossum *et al* 2000). According to Fossum *et al*, while there is a government wide definition of RandD, there is no comparable definition of SandT. From a government perspective while the terms RandD and SandT have been used interchangeably, they do not mean the same. The government perspective is divided into two, namely, the military and the civilian. From the military angle SandT activities are a subset of RandD activities, while from the civilian angle RandD activities are a subset of SandT activities. From within the civilian side of the federal government and in particular for departments such as NASA, DOE and NSF, RandD activities are a subset of SandT activities.

Since no universal definition of SandT has evolved, for the purpose of this dissertation research SandT indicators would continue to refer to the 26 indicators that NSF outlines in its Science and Engineering Indicators database. SandT indicators can thus be defined as a set of attributes of strategic SandT planning which is a quantitative representation of qualitative concept that constitutes SandT indicators and which can be statistically articulated both descriptively and normatively.

The limited research on strategic SandT planning (Calzonetti and Gatrell 2000; Calzonetti, Allison and Gatrell 1999; Gatrell 1999a, 1999b, 2002; Gatrell and Calzonetti 2004) has some key attributes that makes this research bold and inspiring. Set in the backdrop of economic restructuring of the 1980s and 90s, much of the research recognizes the availability of scant economic development opportunities to peripheral regions like West Virginia (Calzonetti and Gatrell 2000; Calzonetti, Allison and Gatrell 1999; Gatrell 1999a, 1999b; Gatrell and Calzonetti 2004) and non-metropolitan areas in states like Michigan (Gatrell 2002), which is where much of the strategic SandT planning research is situated. In their research on SandT planning in peripheral and non-metropolitan regions, there is an acceptance of the fact that if these regions have to develop economically than they will actively need to seek federal, state and local government support to maintain a positive business environment (Gatrell 1999a, 1999b).

In fact, there are many examples to suggest that the so called hi-tech corridors like R 128 in Boston metropolitan area and the Silicon Valley were once peripheral regions but for the active state support that the region received. Thus, according to Calzonetti and Gatrell strategic SandT planning is a cumulative process, which calls for creation of a favorable climate *per se* (Gatrell 1999a, 1999b).

A yet another attribute of the strategic SandT planning research is their focus on various aspects of public strategies for fostering science and technology-based economic development. Much of the articles focus on both federal and state level efforts, significant among which is the Experimental Program to Stimulate Competitive Research (EPSCoR). Calzonetti and Gatrell's research have traced the emerging role of EPSCoR in science and technology-based economic development of West Virginia (Calzonetti and Gatrell 2000; Calzonetti, Allison and Gatrell 1999; Gatrell 1999a, 1999b; Gatrell and Calzonetti 2004). The research by Calzonetti and Gatrell owes its intellectual debt to the ideas of Porter (1990) and `the relationship he established between high technology and competitive strategy. In fact, a careful examination of the work by Calzonetti and Gatrell shows a linear progression in their research at the interface of research and development competitiveness in peripheral regions like West Virginia and the stimulation of the same into technology-based economic development (Calzonetti, Allison and Gatrell 1999). Their research shows that given the availability of factors, such as research and development industry, diverse metropolitan areas, sophisticated workforce, local sources of capital and strong research universities even a peripheral region could become a knowledge region (Calzonetti and Gatrell 2000). The main contribution of Calzonetti and

Gatrell is to provide a convincing empirical demonstration based on primary data collected through a two-stage survey amongst West Virginia manufacturers that existing and emerging industrial RandD clusters were largely due to the impact of SandT planning and these had a positive impact on the economic development of West Virginia.

A related issue of significance within strategic SandT planning research is the important role of the universities in fostering economic development (Calzonetti 2004; Benneworth and Charles 2005; Feldman *et al* 2001; Florida 1999; Huggins and Cooke 1997). Although Calzonetti and Gatrell had successfully demonstrated in their research on peripheral regions such as West Virginia, the role of strong research universities in technology-led economic development, the lack of critical mass of knowledge almost always seems to less favor and permanently disadvantage peripheral regions whether in the North American continent or Europe. Benneworth and Charles (2005) present two case studies from UK and The Netherlands where they demonstrated by developing a conceptual model that University spinoffs are possible outside core agglomerations too in places, such as Newcastle in UK and Twente, The Netherlands. Their findings suggest that university spin-offs are possible in economically less developed regions, too. Similar arguments can be witnessed in the case of University of Wales, Cardiff where Huggins and Cooke (1997) argue that universities have a role to play in the local economic development of the region of South-East Wales. In their research they conducted an impact analysis and concluded that the university contributes to nearly £ 100 million a year and sustains nearly 3000 jobs. Moreover, the university also contributes to the development of regional industrial clusters in the automotive and electronics industry which together builds the Wales region as a learning region. Calzonetti (2004a, 2004b) in his research on the role of emerging universities in local economic development argues that while the success of flagship universities are considered given in university-industry relationships and their contributions to local economic development, it is the emerging research universities like University of Toledo that need to understand, introspect within the university community and examine their local contexts in order to be an active stakeholder in the regional economic development efforts. According to Florida (1999), university-industry partnerships have to be reevaluated in the light of the fact that universities have a primary task of generating knowledge. This line of thought is a departure from the mainstream argument of simply considering universities as platforms for transfer of technology. In a sense, Florida appeals to academics, industrialists and policymakers alike to realize that the ultimate sense of the university-industry relationship has to be maintained in the long run. Then, it is significant that universities continue to do what their primary task is, i.e. 'producing and attracting smart people who are the source of knowledge-based economy' (Florida 1999). Following the same chain of thought, Feldman *et al* (2001) critically evaluate the role of universities as centers of entrepreneurship in the background of Bayh-Dole Act.

In summary, while the role of universities in local economic development has been addressed not only in the literature reviewed here but also elsewhere, there is a growing body of opinion that argues the need for policy intervention in supervising the university-industry relationship from the perspective of their participation in local economic development specifically and transfer of technology broadly. The studies reviewed above share a common concern. There is a need to evaluate the gap between stated policies for technology-based economic development and the current partnership between university and industry.

2.3 Spatialized Public Policy

A uniting theme of this study is regions and the economic processes associated with them. Inherent in the interaction of regions and economic processes are spatial ideas, such as distribution, arrangement, clustering, agglomeration etc. which permeates the notion of interconnection and interdependence over space. The following review explores how, if at all space which has been a basic organizing concept of geography has been a dominant way of doing public policy or in other words is there 'geography of public policy'? (Gatrell and Fintor 1998). To explore the spatialization of public policy we examine the historical development of geography of public policy in the literature. The literature on spatialized public policy seems to display elasticity ranging from highly empirical to highly theoretical works. Three distinct strands of literature are identified.

First, group of scholars discussed conceptual notions surrounding geography of public policy which ranging from the impact of various 'turns', such as institutional, cultural or discursive; to emerging issues in a restructured economy, to the concern of 'policy relevance' (Borchert 1985; Coppock 1974; Cumbers *et al* 2003; Gatrell and Fintor 1998; Henry *et al* 2001; Martin 2000; Martin 2001; Peck, 1999, 2000; Pelletiere and Rodrigo 2001; Pollard *et al* 2000; Rydin 2005; Smith 2001; Storper 2002 and 2000; Turner II 2005; Ward 2005; Wilbanks 1985).

Historically, from the days of Isaiah Bowman and Paul Siple in between the war period, Anglo-American geographers were criticized for not doing enough to be a significant player in public policy domain. In fact, to undo the frustrations of being left out from the post-war development planning processes, geographers began to focus on spatial relationships or spatial interactions so much so that space began to be considered a variable (Cox 1995, 1996a, 1996b, 1997, 1998a, 1998b, 2002). While the regional concept *per se* was not abandoned, it grew and flourished under the "spatial-scientific" notions of geography. A resurgence of focus on 'space' in geography was accompanied by the quantitative revolution with its reliance on observation, experimentation and comparison (Johnston 1991).

Exploring the interrelationship between geography and the politics of public policy making, Gatrell and Fintor (1998) argued that public policy making is about creation of 'policy image'. The authors introduced notions of 'spatial niche' and 'policy subsystem'. Though the Appalachian Regional Commission (ARC) was created in the interest of Appalachia as a region for it had been poverty ridden and was in isolation, much of it is now policy 'myths' to be conceptualized as regional 'myths' even though there has been a proliferation of several such other regional policy 'myths', such as the Tennessee Valley Authority (TVA), the Atlanta Regional Commission a 10-county region, the Northeast Ohio Trade and Economic Consortium (NEOTEC) which is a ten-county economic development partnership among many others. In short, Gatrell and Fintor make a strong case for spatialized public policy as spatial processes, such as clustering and agglomeration have come to occupy a centre stage and economic development has increasingly become place-specific.

Gatrell and Fintor were later joined by Martin (2001) in making a plea for a new '*policy turn*' in the discipline of geography. Martin differed in his approach from Gatrell and Fintor while making his plea for a policy turn. According to Martin, the notions of institutional turns and cultural turns were simply in consequential linguistic and theoretical issue, while geographers according to him, should have been focused on detailed rigorous empirical work so that a stronger case for spatialized public policy could emerge (Martin 2001).

One review of the relationship between geography and public policy demonstrates that geographers concern with the inherent challenges, opportunities and implications are fairly old (Coppock 1974). According to Coppock, geographers have not shown much interest beyond teaching and research. While this might have been the scenario in the 1970s, geography began to have substantial impact on public policy making in the 1980s. In particular, in the United States at the national scale public policy making is geographic (Wilbanks 1985). According to Wilbanks, geographers have contributed to policy making with its attributes like identification of spatial patterns, relationships and structures. In the past, spatialized policy making has included multipurpose river development like the Tennessee Valley Authority project, national parks system, and several others related to housing, urban transportation, neighborhood structure, community development, locational conflict and the like. Mention maybe made among others of Gilbert F. White's federal floodplain policy (Turner II 2005), T.R. Lakshmanan's forecasting the environmental consequences of different energy policy options and David Greene's analytical model for understanding the determinants of highway gasoline use (Wilbanks 1985) among many others. These models recognized and were constructed based upon an understanding of differential population distribution. In short, the evolution of geography of public policy owed itself to the disciplinary matrix of spatial science which started in the 1960s and sustained since. However, much of the spatial science literature with policy implications of the 1970 and 80s were challenged by the proponents of humanistic geographers who felt that geography of public policy was too technocratic in its orientation, reducing people and regions into equations.

The year 1999 saw a debate initiated by Jamie Peck on policy relevance in geography under the title 'grey geography' (Peck 1999). In the editorial columns of *Transactions of the Institute of British Geographers*'s Jamie Peck an economic geographer raised several provocative and polemical issues which includes and is not limited to the following, that there is a conspicuous absence of policy debates in geography, that policy research seems to have attained the status of 'grey' or the other of academic research, that policy research is heard of as being referred to as getting one's hand dirty dealing with cash, clients, contracts and reports-in-cardboard-covers so to say, that the separation of academic and policy is damaging since they are not mutually exclusive (Peck 1999). These and such other concerns were highlighted by Peck in this editorial. Some British geographers such as Jane Pollard, Nick Henry, John Bryson and Peter Daniels responded to Peck's clarion call on a missing grey geography as an issue of fraught relationship between geography and policy process. Pollard *et al* responded with disagreements on Pecks claim that geographers have on the whole been conspicuous by their absence from substantive policy debates (Pollard *et al* 2000). While Pecks claim have been given the status of being legitimate, non-trivial and potentially creative, Pollard *et al* point out that when Peck talks about relative dearth of policy work in geography he is essentially talking of 'one particular form of policy work'. In sum, Pollard *et al* claim that there are many shades of grey policy work carried out at different scales: local, regional, national and supranational that deserves recognition. While the debate carries on, it brings up one fundamental issue for economic geographers in particular and geographers in general, those being the level of the hierarchy of policy engagement, those geographers want to be, i.e. whether they want to be at the outcome-evaluation end or deeper policy formulation end. In sum, it seems this debate on geography and policy relevant research was more a desire on the part of Jamie Peck on the proliferation of policy work, versus Pollard *et al*'s appreciation of ongoing policy work in geography which was addressing multiple demands and audiences. While, Peck may have formalized the debate and provoked reactions, this was by no means the first of sorts for as early as 1985; Borchert raised the issue of the need to geographically restructured policy questions bound with the significance of regions and the topic under consideration (Borchert 1985). Borchert was referring to the need for state and local policies on revenue, expenditure and regulation which shaped and constantly changed the settlement mapping of a region. Thus, issues of structure and organization in policy making by geographers has been of significance since long.

Under the impact of humanistic philosophy there emerged various turns, such as institutional, cultural and discursive within geography, which provided a temporary setback to the disciplinary matrix of geography of public policy. Not to forget that there has also been recently some talk about a 'policy turn' (Smith 2001). The grey debate apart, some scholars like Cumbers, Mackinnon and McMaster are of the view that economic geography and regional development seem to neglect policy research on the effects of wider processes of uneven development and in particular since there is no consensus about the definition or understanding of region (Cumbers *et al* 2003). On the other hand, the discursive turn, too, has been blamed for inducing a lack of engagement between geographers and policymakers. In his work Rydin (2005) argues that such a view is flawed for it ignores the positive contribution that any discourse analysis can make to policy studies and the particular role that geographers can play in such research outcomes. In fact, Rydin is of the view that critical knowledge is constructed within the policy process which can even help identify how policy can be improved through discursive means (Rydin 2005).

Today's context of economic geography and its links with policy making has undergone dynamic change under the impact of economic restructuring and because of the proliferation of the knowledge-based economy and flexible specialization together have brought in a kind of elasticity and competitiveness never seen before. One impact of economic restructuring has been that geographers have begun to ask new regional policy questions largely under the impact of redefinition of space (Pelletiere and Rodrigo 2001). Space itself has come to have a whole new meaning in a world which is now digitally divided having tremendous impact on the traditional notions of distance, region, location, and place as well as spatial notions of distribution, clustering, agglomeration etc. Thus, there is a need to revisit emerging regional policy questions which are guided by access to the physical network, the capacity to share information on this network, differential access to information and inequality among the user base. These new concerns in regional economic development policy in a way create opportunities and obstacles which further determine how spatial policies will be designed. These concerns of geographers like Pelletiere and Rodrigo are also shared by Storper, who proposed the notion of a new heterodox policy framework (Storper 2002 and 2000). This framework is sympathetic to spatial contexts and has certain attributes, such as networks, flexibility, decentralization, cooperation, research and development, human capital, technopoles and training (Storper 2002 and 2000). In other words, both Pelletiere and Rodrigo (2001) and Storper (2002 and 2000) share some thematic concerns in the geography of public policy making. They are both about contextualizing, flexibility, constant measurement and mapping of the changed circumstances in which economic geographers do policy making.

Recent developments in the geography of public policy include the issue of policy relevance. Henry *et al* (2001) are of the opinion that economic geography in particular lacks clout with its policy audience since the discipline has had a long aversion to detailed empirical work and, secondly, unlike economics it lacks rigor and scientific status. In a detailed review of recent developments of geography and public policy Ward (2005) concludes that for geographers to be successful with their policy audience, it is important that they take their work to that audience for greater clarity. It seems that policy relevance has much to do with customizing geography to different contexts. Therefore, in today's world of regional convergence, public policy seems to have acquired a new relevance as spatial concentration of economic activities is also one of the most salient features of the last phase of economic restructuring (Martin 2000). As a result, and more so in developed economies, spatialized public policy seems to have acquired significance as policies have to constantly adapt themselves to address any possibilities or potentials of uneven development in space, the idea being to provide society with opportunities for equity and efficiency (Martin 2000).

A second group of scholars argued about the role of public policy in development of regions since increasingly local economic development was getting associated with innovations (Acs and Varga 2002; Baxter and Tyler 2007; Chesire and Magrini 2000; Digiovanna 1996; Ettlinger 1994; Gibbs *et al* 2001; Hotz-Hart 2000; Mothe and Paquet 1998; Scott 1992; Simmie 1997; Sternberg 1997; Varga and Schalk 2004). A considerable literature has emerged on the interface of policy making, local economic development and knowledge-based economy. In broad terms since the 1990s, the economic geography and regional development and planning literature has emphasized on agglomeration and flexible production from a strategic perspective through a network of transactions (Scott 1992), on development as a bottom-up phenomenon through partnerships to achieve local development (Ettlinger 1994), on the role of space in innovation and technological development within a global/local interface (Simmie 1997), and on the recombination of local knowledge, skills and technology in the Silicon Valley (Saxenian 1994 and 1998).

Scotts work on flexible production agglomeration is a significant one, as it argues that the shift from fordist to flexible accumulation regime involves transactions which are not only interregional but also at the interface of global and local, involves rearticulating of regional development policy. Thus, spatialized policy making was earlier for the manufacturing belt in the United States, or the stagnant old industrial region like the Central Valley in Scotland, whose economies were concentrated on large-scale mass production. This was largely the result of spatialized view of regional development set up by theorists like Hirschman, Myrdal who talked about core and peripheral regions. Even in a regime of flexible production it was a spatialized regional development policy undertaking that created the Silicon Valley in California, and such outcomes as the Third Italy, knowledge region in southern Germany or the scientific city of the Paris basin or more recently the creation of knowledge regions like Bangalore – India's Silicon Valley or the case of Kyushu region in Japan. According to Scott (1992), since flexible production quite often eventually leads to uneven development, there arises the need for local economic development policy initiatives. In discussing localized development, Ettlinger (1994) takes the view that local economies are tied to national mode of production of which they are a part. To understand localized development planning Ettlinger conducts a comparative study of local development experiences in the United States and in European countries, such as Britain, former West Germany and Italy. According to Ettlinger, local policy changes in such cases are a matter of structural change. Ettlinger (1994) and Scott (1992) both look at mode of production in evaluating local economic development from an institutionalist perspective in economic geography. However, their understanding of place differs. To Scott (1992), a place was conventional in its meaning; while for Ettlinger (1994), it was a community of intangible synergy as a result of networks.

The next three articles reviewed in this section are case studies capturing the experiences from Kyushu, Japan; Aberdeen, Scotland; Hertfordshire, UK and Silicon Valley, US at the interface of policy making, local economic development and knowledge-based economy (Cumbers *et al* 2000; Simmie 1997; Sternberg 1997). The Japanese case of Kyushu is a case of a region experiencing revival. Kyushu which is characterized by high-tech employees, relatively low cost and well trained labor, provides a comparative advantage which the regional and technology policy of the Japanese government has taken advantage of by integrating its strategies in favor of national competitiveness and large enterprises (Sternberg 1997). Unlike the case of Kyushu, the factors which made Hertfordshire in UK, a knowledge base were besides the usual ones also reasons such as availability of venture and long-term capital from London area. Thus, policy making is not always necessarily contributing to innovative activities. However, in the case of Aberdeen, traditionally a branch plant region, witnessed policies that created opportunities for local advantages in the creation of learning relationships with the branch plants of global corporations. Thus, spatial policy support mechanism can cause synergy between global and local niches (Simmie 1997).

Through a review and reexamination of literature spanning the works of Paul Krugman's ideas on new economic geography, the new growth theory of Romer and the new economics of innovation of Nelson, Acs and Varga (2002) try to understand why some regions grow and others stagnate. They ask several fundamental questions, such as why and when does economic activity become concentrated in a few regions leaving others relatively underdeveloped; secondly, how does technological change impact regional economic growth and, finally, what institutions and processes lead to advancement in technological change. Varga and Schalk (2004) in their work studying the relationship between knowledge spillovers, agglomeration and macroeconomic growth, on a Hungarian database modeled that knowledge spillovers tend to be localized. As a result, innovations have the capacity to change spatial economic structure (Varga and Schalk 2004). The above review and the modeling example bring out the significance of endogenous growth theories in knowledge spillovers and innovation processes such that it affects public policy. In an attempt to understand regional growth processes, Chesire and Magrini (2000) used empirical approaches to study endogenous processes in nearly 122 functional regions in Europe. They modeled the significance of endogenous processes by displaying that technological knowledge had a significant contribution to regional growth and had policy implications.

The next set of articles within this segment emphasizes upon the need to have a grasp on the processes that determine spatialized policy in places. Recent literature on local development and innovations (Mothe and Paquet 1998) has stressed the need to understand economic dynamics of local and regional systems of innovations. While the work of economic geographers, such as Saxenian (1994 and 1998) and Florida (1995) besides others have given us some ideas on which we have built an understanding of the structures of these regional innovation systems in places, yet a clear policy undertaking requires that we understand their processes for they are often not linear, but involve networks. Thus, the author's stress spatializing policy would need an appreciation of the meso systems of innovations which relate firms and national economy (Mothe and Paquet 1998). While Mothe and Paquet (1998) raise the concern that innovation systems do not seem to have an 'optimal size' or 'one-best-spatial-size', rising policy concerns and issues of politics of scale finds focus again in the work of Gibbs *et al* (2001). According to Gibbs *et al* (2001), the significance of local and regional economic development sites have expanded as focus have come to lie upon institutions in a region. Gibbs *et al* are of the view that while policy making is shifting to nontraditional institutions yet the success of local and regional economic development is important. They arrive at this conclusion based upon empirical evidence from the Humber sub-region of UK. The significance of Gibbs *et al* work is that the empirical evidence gathered here is not from a core but a lagging region.

A yet another conceptualization of regional economic development is the industrial district (IDs) model. While there is an assumption that most IDs follow similar modes of production and labor relations, Digiovanna (1996) in his study of Emilia Romagna in Third Italy, Baden-Wurttemberg in southwest Germany and the Silicon Valley uses the regulation approach and arrives at the conclusion that sustainable economic development was essentially a product of distinct social relations that emerge in places. According to Digiovanna, while formal policy institutions do not create conditions in these places for the success of IDs, they can definitely create conditions for the sustenance of these social relations so that these IDs can achieve regional economic development. This spirit seems to be preserved in the work of Hotz-Hart (2000) who argues that whatever be the scale at which clusters of innovation systems operate, their success is dependent upon networks of factor endowment, such as regional knowledge base, knowledge infrastructure, adequate institutional framework, financial system and technologically sophisticated home market. The role of networks has also been discussed in a recent work on 'enterprising places' by Baxter and Tyler (2007). According to Baxter and Tyler, the growth of high-tech regions whether in and around Route 128 in Massachusetts or Scotlands central belt, are largely due to policy intervention represented by public and private agents. In other words, it is the collective activities of the policy intermediaries in response to crisis presented periodically that sustains these enterprising places.

A third strand of work seeks to account for role of policy in the economic development of peripheral regions (Calzonetti, Allison and Gatrell 1999; Calzonetti and Gatrell 2000; Ceh 1997; Doloreux 2003; Feldman and Link 2001; Gatrell 1999; Gatrell and Calzonetti 2004). In their attempt to be identified as innovation or knowledge-based region, peripheral regions have the challenge to overcome their comparative disadvantages with respect to their factor endowments. Much of the role of policy lies in supporting to build innovative capacity in peripheral regions. In this respect Wiig and Wood (1997) present a theoretical and empirical study of a non-metropolitan area. The study which focused on Møre and Romsdal region in Norway is actually a peripheral region, and uses data from a comprehensive survey of innovations among manufacturing firms. Through this research the authors argue that the interface of policy and innovations must focus on peripheral regions rather than those of successful regions (Wiig and Wood 1997). Gatrell (1999) too emphasized on the need to rethink economic development in peripheral regions. His main argument was while economic development has for long focused on branch plants and back offices in peripheral regions or non-urban spaces or non-metropolitan spaces, the time has now come when under the context of an emerging new economic geography characterized by spatial division of labor, producer services, information technologies etc. there is a need to rethink economic development. Gatrell's research identifies issues such as methodological problematic in studying non-urban spaces for data have not been disaggregated for non-metropolitan areas or peripheral areas thus causing concern.

In their research (Calzonetti, Allison and Gatrell 1999; Calzonetti and Gatrell 2000; Gatrell 1999 and Gatrell and Calzonetti 2004) on West Virginia a peripheral state, there has been a steady focus on strategic science and technology planning. In a sense, Calzonetti and Gatrell in their research make a linear progression from trying to assess West Virginia's technology capacity to examining the challenges that West Virginia as a lagging state would face in trying to become a knowledge region to an assessment of existing and emerging RandD clusters as a result of strategic science and technology planning. In the process there is an acceptance of the fact that for West Virginia to develop as a technology-based economy they would need local infrastructure, institutions and service providers to be able to achieve that much required competitiveness (Calzonetti, Allison and Gatrell 1999). Policy prescriptions include the need to build partnerships between university, industry and government, to adopt a competitive cluster strategy, and to capitalize on existing strengths, such as strong chemical industry and the ready availability of extractive industries. While West Virginia has been identifying focus areas for strategic science and technology planning, Calzonetti and Gatrell (2000) also present challenges that the state may face as an emerging knowledge region. The challenge lies in building on existing strengths of industrial development or to move into new and emerging areas of science and technology-based economic development. In this process, the state has already put in position a statewide science and technology advisory council to develop appropriate science and technology planning strategies for the state in the short and long run. Thus, West Virginia has seen an articulation and expansion of targeted science and technology enhancement. This consists of a larger catalytic role played by West Virginia University in the development of a spatial strategy that grows local economies, the growth of West Virginia's EPSCoR program, and targeted federal support-based institutional and workforce development.

While Calzonetti and Gatrell's research focuses on peripheral areas in the US, there is similar evidence of research on peripheral areas in Canada, too (Ceh 1997; Doloreux 2003). While Ceh (1997) examined a typology of Canadian inventive enterprises at different scales – national, subnational and urban levels between 1975 and 1989, his work analyzed both core and peripheral regions. An urban and regional analysis of Ceh's findings shows that the spatial extent of Canada's inventive enterprises was initially concentrated in the core region between Quebec City and Windsor (which includes cities of Toronto, Montreal and Hamilton), while the periphery was beyond that area. The core held close to 87% of the total inventive enterprises. However, post 1989 Canada has seen a higher share of process inventive activities in the periphery which includes places, such as Vancouver, Calgary, Winnipeg, Valcourt and Sudbury. A difference between US and Canada's innovation system lay in the fact that to understand the Canadian inventive enterprise system one had to track them both at spatial and non-spatial level. A yet another uniqueness of the Canadian inventive enterprise system was that development in the periphery in Canada was prevented because of lack of participation by foreign-owned enterprises in comparison to indigenous enterprises (Ceh 1997). Like Gatrell and Calzonetti's focus on peripheral regions in the US, Doloreux (2003) has shown interest in Canada's regional innovation system with a particular focus on the peripheral regions. In particular this research looks at the regional innovation system from a spatial perspective and tries to explore the innovation process of small and medium enterprises (SMEs) in Beauce region of Québec, Canada. More specifically, the research focus lies on how innovation arises in one peripheral region, including an investigation of activities and capabilities of firms located in the region. Like Gatrell and Calzonetti's research on West Virginia's strategic science and technology planning capability, Doloreux too draws his information based upon empirical research wherein the primary data was collected through a multiple stage process of data collection. In fact, their methods are very similar. However, the findings for Beauce region, too, show some striking similarities with that of West Virginia. As in the case of West Virginia, Beauce region too focused on product and process innovation thereby capitalizing on its regional entrepreneurial skills and positive trickle-down effect of being in close proximity to the wider Québec metropolitan area.

2.4 Politics of Scale

In conceptualizing upon strategic science and technology planning-based economic development, the issue of 'scale' emerges as not just significant but fundamental (Cox 1989, 1996a, 1996b, 1997, 1998a, 1998b). This is primarily because scale is concerned with space in geography and spatial processes are inherently political. This dissertation research is focused on spatial scale among others like temporal, phenomenon and thematic scales.

Cox (1989) in reviewing localities mentioned that theorization of locality was closely related to scale. Later, Cox and Mair (1989) argued that in social science research, scale was a methodological device and that the choice of scale for pursuing research question simultaneously presented conceptual and political issues. Cox (1995) feels locality and scale as closely related and yet a focus on spatial analyses does not bring about any discussion on scale. Later, Cox (1996) in his editorial comments highlighted the difference that scale makes in geographic research. Trivial as it may seem, there are plenty of journals whose titles itself indicate one or another hierarchy of scale. Cox was referring to journals like *The International Journal of Urban and Regional Research, The Journal of Urban Affairs, Urban Studies,* and *Regional Studies,* among many others. Place signifies something local in scale and so is contrasted with global as a larger scale. The local-global debate assumed significance as the local feeds the global. Much research by Cox and his associates feed upon strong reference to conceptual ideas at a local scale, such as new urban politics, growth coalitions, politics of local economic development (Cox 1995, 1996a, 1996b, 1997, 1998a, 1998b, 2002, 2004;

Cox and Mair 1988, 1989, 1991; Cox and Wood 1997). In so much, the issue of scale becomes political as it is bound up with cleavage and conflict. The notion of 'politics of scale' has been accused of attaching too much significance to place at different sub-national scales such as Piore and Sable (1984), new industrial spaces of Scott (1992), locality of Massey (1991 and 1993), and new urban politics of Cox (1995). Thus, in each one of these cases, scale comes with a qualification, in other words scale seems to be socially constructed (Brenner 2001 and 2000; Delaney and Litener 1997; Marston 2000; Smith 1990). Smith (1998) critical of Cox's articulation argued that Cox was looking for global spaces in local politics. More specifically, Smith is critical of the manner in which Cox articulates the global with the local. Unlike Smith, Jones (1998) in response to Cox (1998) Spaces of Dependence and Spaces of Engagement argued that there is a need to think of scales not as an areal unit, but as a network of interaction. Jones (1998) is of the view that when Cox brings too much global into the local, he is essentially not jumping scales, but using this as a political strategy of shifting between spaces of engagement. In response to Cox (1998) "spaces of dependence" and "spaces of engagement", and the "politics of Scale", Judd (1998) argues that Cox overestimates the ability of politics to overcome politics of dependence through social construction of politics of engagement. Elsewhere, Cox (1997) while referring to places such as Silicon Valley, Route-128 in Boston, MA, Third Italy asserts the coming of the new replacing old at sub-national scales within the notion of new economic geography. Unlike Cox, Brenner (2001 and 2000) in talking about politics of scale, debates about the process of globalization as one that encompasses a broad range of themes. He suggests that little theoretical consensus has been established around the process of globalization which creates problems for both, scale and space. In response, scale conflated with broader discussions of space and scale had nothing to do with hierarchy as have been popularly accreted (Marston and Smith 2000). Marston and Smith (2000) responded by suggesting that Brenner was reading scale through Lefebvre. Theorizations of scale inadequately address processes of social reproduction and consumption, thus, making the concept of scale highly dependent on production. Pendras's (2002) views differ in that the politics of scale has resulted from a changing international political economy which was essentially because of shifting conditions at the local scale. In so much, urban politics and politics of scale had implications for progressive local development affecting local ownership, regulation, and market development.

The literature suggests that place has a tendency to assert power at the local scale in the post-Fordist era of globalization, decentralization, and deregulation. Thus, the local scale has become more constrained by extra-local forces. The interaction of space and scale with innovation makes use of a range of scales from global to sub-national, leading to the local as well as notional scales such as network and firms etc. The role of firms and individuals as key actor's insistence of innovations comes out rather significantly. Focusing on one spatial scale seems inadequate for a full understanding of spatial processes of innovation. Thus, there is a need for multi-scalar approach in understanding interaction of regions with economic processes.

Taken together, the articles in this literature review point to the significance and diversity of perspectives on regions and economic processes. Moreover, they also highlight plural and competing visions of space in the interaction of regions and economic processes. Most of the articles display and illustrate conflict and competition in the interaction of SandT planning and practice to achieve local economic development. Further, they also bring out the role of scale, spatialized public policy, particularly at the sub-national level.

CHAPTER 3

HISTORY OF EPSCOR

3.1 Background

The twenty-seven jurisdictions that make up the Experimental Program to Stimulate Competitive Research (EPSCoR) have played a significant role in recognizing the relationship between state science and technology efforts and the state economic development function. Although the functions this program now serves are quite different than those for which they were originally intended, they continue advancing the social and economic objectives of underdeveloped regions. Created in 1978 by the US National Science Foundation (NSF) in response to Congressional mandate, the program supports academic RandD in states that historically have been among the most underdeveloped in terms of their scientific and technical capability as also their capacity for economic development.

The creation of EPSCoR was based on the fundamental notion that economic growth occurs with the production and consumption of more goods and services in an economy. Particularly those economies in the peripheral regions who want to stay competitive in a globalised and restructured world market. Under the circumstances states and regions have to learn to produce higher quality and greater variety of goods and services using fewer resources. In so much, the degree to which more can be produced with less reflects increases in productivity in the economy. In all this, technology is one of the fundamental forces driving increases in productivity and a growing and competitive economy.

While a basic input into the process of technological innovation is research and development, some in the US Congress, as far back as late 1970s were alive and aware of the fact that not all state economic development was attuned to connections and linkages with science and technology. Particularly in small towns and rural areas, economic development remained untouched by the impact of knowledge revolution. In other words, much of the lagging states of the US continued to guide its economic development through location, recruitment, incentives, and business climate. It was this thought process that guided Congressional mandate to NSF in 1978:

> "… it shall be an objective of the Foundation to strengthen research and education in the sciences and engineering, including independent research by individual, throughout the United States, and to avoid undue concentration of such …" (US Congress 1978)

Thus, it may not be wrong to conclude that the emergence of EPSCoR was also in the backdrop of declining productivity between 1973 and 1979 when the average rate of growth of labor productivity was only 0.6 per cent. Moreover, the decline of fordism and rise of flexible production system too provided a paradigm shift with its concomitant impact on the manufacturing sector's slump in productivity which provided a new lens of how economic development was being viewed in the US.

This chapter outlines a historical overview of the creation of EPSCoR as a product of the development and implementation of Congressional mandate to NSF of 1978. Included are not only a chronology of events, but a critical look at the program with a view to understanding EPSCoR's strength and weaknesses and its evolution over time, even as it changes its mission taking on new functions and raising its expectations. This historical context would serve as a backdrop in understanding and appreciating the spatial distribution of science and technology indicators across states and land grant institutions and how their uneven distribution complicates SandT planning.

3.2 Development of EPSCoR: Implementation and Amendment

Among the ideas and sentiments which eventually culminated into the creation of EPSCoR, one will find the 1977 conversation between Member of Congress Ray Thornton (Democrat from Arkansas) and former Director of National Science Foundation Richard Atkinson rather interesting. In 1977, Atkinson the 17th president of the University of California was testifying before the House Subcommittee on Science, Research and Technology. Atkinson was asked by Ray Thornton how much NSF money his state received. Though Atkinson knew, but he felt the sum was so embarrassingly small that he did not want to give the figure in public, so he said he would get back to the Congressman later with the answer. Minutes after the hearing, Atkinson explained to Thornton his dilemma who in response asked Atkinson "Can't we encourage scientific research in areas of the country that are not traditional providers?" Atkinson said, "Yes, I believe that is part of our charge." This interchange, interesting as it may seem, also provided a significant input for the creation of NSF's Experimental Program to Stimulate Competitive Research (Lambright 1999). In fact, till then, Arkansas received some $ 324,000 in 1976, about 0.1% of NSF's total awards, while South Carolina's share of NSF grants was $ 319,000 and West Virginia's was $ 223,000. Compare this with California's share of $ 60 million and $ 49 million for those in New York (Hauger 2004). Thus, while the creation of EPSCoR itself was based upon interstate disparities in NSF funding patterns, such disparities themselves were seen as a product of inequalities in states SandT assets.

The first EPSCoR awards were made to five states (Arkansas, Maine, Montana, South Carolina, and West Virginia) in 1980 to undertake a five year program of self improvement with no expectation of further continuance.

Table 3.1

NSF EPSCoR States – A Timeline

Year of Entry	**States**
1980	Arkansas, Maine, Montana, South Carolina, West Virginia
1985	Alabama, Kentucky, Nevada, North Dakota, Oklahoma, Puerto Rico, Vermont, Wyoming
1987	Idaho, Louisiana, Mississippi, South Dakota
1992	Kansas, Nebraska
2000	Alaska
2001	Hawaii, New Mexico
2002	Virgin Islands
2003	Delaware
2004	Tennessee, Rhode Island, New Hampshire

Source: National Science Foundation

As of 2009, 25 states, the Commonwealth of Puerto Rico, and the territory of the Virgin Islands participate in the NSF's EPSCoR program (Table 3.1). States became eligible to participate in EPSCoR on the basis of criteria determined at the state level rather than at the individual or institutional levels as is more common among NSF programs. As such a state's eligibility was determined on the basis of a host of index which included among others, historical levels of funding received from NSF and the federal government at large along with a host of socio-economic indicators. Through EPSCoR, NSF established partners with leadership in state government, higher education and industry to affect lasting improvements in EPSCoR jurisdiction's research infrastructure and its national research and development competitiveness. In so much, EPSCoR turned out to be a multiagency effort with participation from such federal agencies as the Departments of Agriculture, Defense and Energy, the Environmental Protection Agency (EPA), the National Aeronautics and Space Administration (NASA), and the National Institute of Health (NIH). Some of these have created their own EPSCoR programs. Built in this multiagency nature of EPSCoR was participation by state legislators who regularly advised its progress in their jurisdiction while EPSCoR representatives individually and as a group also held regular scientific update meetings with federal congress people and their legislative assistants.

The evolution and growth of the NSF EPSCoR program saw several stages. Initially, seven states were invited to submit proposals in 1979: Arkansas, Maine, Montana, North Dakota, South Carolina, South Dakota and West Virginia. All but five states were finally awarded to the tune of $ 3 million to be provided over a period of 5 years, in what constituted the first cohort of states. Neither of the Dakotas was awarded in the first round. Upon completion of the five year period in 1985, NSF was reluctant to continue the sheltered support to states, however, it was the presentations from the five original states and request from many others to join the program that led NSF to award grants to a second cohort of states (Alabama, Kentucky, Nevada, North Dakota, Oklahoma, Puerto Rico, Vermont, Wyoming) besides, also providing the original set of states a small continuation grants. While both the Dakotas were allowed to compete in the second round, only North Dakota was awarded. In 1987, when a third cohort was awarded South Dakota too wrote a winning proposal besides Idaho, Louisiana and Mississippi. Over the years, additional states were admitted into the EPSCoR program: Kansas and Nebraska in 1992, Alaska in 2000, Hawaii and New Mexico in 2001, the Virgin Islands in 2002, Delaware in 2003 and, finally, Tennessee, Rhode Island, New Hampshire in 2004.

Since 1980, EPSCoR has grown from a $ 2M or $ 3M per year program involving just five states to an investment that has grown to $ 120 M supporting efforts in 25 states, the Commonwealth of Puerto Rico, and the territory of the Virgin Islands (Hauger 2004). Originally, EPSCoR was designed to enhance the ability of eligible states to compete for peer-reviewed federal and NSF research grants, however, over time, its mission expanded as the program took new functions raising its expectations.

In fact, in implementing EPSCoR, NSF made three significant decisions to shape the program in important ways, namely: (a) to organize the program on a state basis, (b) the prerequisite of requiring matching funds from the states to NSF grants, and (c) requiring each state to have a statewide EPSCoR Committee for planning and implementation. Over the years, NSF-EPSCoR proposals have witnessed an explicit and extended reference to economic development and related activities. As such, NSF sponsored EPSCoR has clearly evolved into a program that fosters science-based economic development, an extension of the best science paradigm on which NSF and EPSCoR were founded. Thus, there have been significant shifts in its perceptions and policy, one where EPSCoR has begun to represent a general national trend towards partnering academic research with economic development (Hauger 2004). EPSCoR now has a history of thirty years of effort to foster scientific competitiveness in states that had not historically won many federal research dollars.

3.3 Trends in SandT Planning

In the above examination on the history of the growth of EPSCoR a clear trend emerges towards recognition of the broader role of technology in economic development. This was first noticed in the proposals submitted to the NSF-EPSCoR by states such as Maine in 1990, whose proposal categorically stated as its objectives "to develop and implement a long range plan for integrating SandE research, education and development into the state's economic development strategy". Similarly, Oklahoma's proposal identified "assistance in the relocation of technology sensitive industry to Oklahoma". Other states such as Alabama, South Carolina and Wyoming, too, cited economic development goals in their proposals during 1990-91 (Hauger 2004). Thus, EPSCoR states were becoming increasingly sophisticated in their economic development planning efforts which were eventually becoming feeders into their industrial policy.

The strategies adopted by EPSCoR states simply epitomized what was happening elsewhere in states, such as Washington, Nevada, Florida, Colorado, Illinois, California, Utah, Georgia, Arizona, to name a few. These states were characterized in their economic development planning efforts by four important features firstly, partnership between public and private sectors; secondly, avoid an emphasis on attraction but put an emphasis on expanding existing industries; thirdly, aim at building a new economic base of small and usually high-technology, growth-oriented firms; and finally, linking existing strategies to budget allocations and to ongoing program evaluation (Bradshaw and Blakely 1999).

An examination of the SandT -based economic development policy over the years clearly demonstrates that states have gone through periods of evolution in design and focus. From a historical perspective, there have been four distinct periods in the evolution of SandT planning or what maybe called state technology-based economic development efforts.

3.3.1 Pre 1980s

During the 1960s and 70s, the US Department of Commerce and the NSF strongly encouraged states to establish the position of Governor's Science Advisor and a state science and engineering foundation which would parallel the position of President's Science Advisor, primarily a NSF federal model. Those states which acted on this advice and created such positions were clearly interested in building their states science and technology enterprise. The ensuing policy making almost everywhere had no focus on economic development. Several states established their state advisory bodies in the 1960s with support from such programs like State Technical Services (STS) program which was cancelled in 1969. Much of these advisory bodies were created to advice on environmental issues such as pollution, solid waste disposal and energy. Later in 1977, Congress authorized NSF to establish the State, Science, Engineering and Technology (SSET) program whose objective was to help states develop and implement SandT related strategic plan. The legacy of both the STS and SSET programs was the creation of a Governor's SandT advisor's position or an advisory board or a science and engineering foundation, though a large number of these have now been either abolished or merged into economic development agencies in the 1990s. Thus, the period before 1980s saw a focused SandT planning process (Plosila 2004).

3.3.2 The 1980s

By now, the country was witness to local economic development experiences in the form of MIT led Route 128 corridor in Massachusetts, Stanford University led Silicon Valley in California and the University of North Carolina and Duke University led Research Triangle Park in North Carolina. Though each one of these experiences were built upon different models such as entrepreneurial or recruitment-based, a popular perception in policy circles was that such experiences could be replicated with the creation and customization of similar circumstances. While this period saw the emergence of state SandT programs having direct links with economic development programs, much of this was happening because they were university-centric programs.

In this new wave of SandT led economic development, the focus for states was on recruitment of 'trophy projects' such as Microelectronics Computer Consortium (MCC) and the Semiconductor Technology and Enterprise Corporation (SEMATEC) which all went to Texas largely because of the platform and resources provided by the University of Texas at Austin in the form of endowed chair positions, university linkages and connections, and access to talent pools. This example set by Texas was quickly emulated by other states, such as North Carolina, Connecticut, Georgia, Pennsylvania, Ohio and New Jersey. A common element in all these states was the presence of strong research universities. Georgia's efforts at economic development was routed through its Advanced Technology Development Center at the Georgia Tech, while in Pennsylvania and Ohio the leaderships came from the office of the Governors Dick Thornburgh of Pennsylvania who established the Ben Franklin Partnership Program and Richard Celeste in Ohio who started the Thomas Edison Program. Both these programs replaced the former SANDT apparatus that was created in the states in pre-1980s. Similar state programs emerged from leaderships in public and private universities in other states. These programs were characterized by the ability to take risk, provided credibility, brought higher education to the economic development table and increased awareness and importance of entrepreneurs. Besides, these programs also looked at leveraging state funds, through new forms of organization, competition and incentives, a comprehensive and integrated framework and above all accountability for performance (Plosila 2004).

As universities became active in economic development, this period was thus characterized by partnerships between the private sector, the university and the local and state governments, a model known as the 'triple-helix'. Such was the emphasis and pervasiveness of this model that it saw its culmination in the creation of the $ 385 million State Science and Technology Institute in 1996 (Plosila 2004).

3.3.3 The 1990s

In the 1990s, one witnessed the consolidation, maturation and institutionalization of the linkages between state SandT and economic development. Throughout the 1990s, many states developed comprehensive technology strategies involving technology trade associations, policy makers, legislators and higher education institutions. No longer was SandT regarded extraneous variables in economic growth, rather it became a critical variable for the growth of future economies. Embedded in this model of institutionalization of SandT was the recognition of and commitment to entrepreneurship. Thus, focus was paid to small and medium enterprise firms compared to traditional state economic development focus on large firms. In this process NSF encouraged the establishment of University-Industry Cooperative Research Centers, which became incubators for small firms. These institutions became instrumental in technology transfers and drawing of venture capitals. While, the state governments were doing their best to encourage and build economies, the federal government established Manufacturing Extension Partnership Program (MEP) with a view to speed up the process of technology transfer right off the shelves and increase competitiveness of small firms.

Thus, the 1990's was characterized by expansion of SandT based economic development in states, with redefinition of technology alliances and university-industry partnership with a view to bring about technology transfer. By 2000, nearly all the states recognized the significance of SandT-based economic development.

3.3.4 The Present Decade

In the last nearly seven to eight years, trends in SandT based economic development have witnessed some characteristic features such as creation of industry clusters with multiplier effects and a focus on regional growth and development. In doing so strategic SandT planning relies upon the following factors, namely, building on existing areas of industrial strength, drawing on strong research universities, relying on dense networks of firms, specialized workforce, and using local sources of capital (Calzonetti and Gatrell 2000).

Regions rather than states in the form of counties and metropolitan areas with the active participation of universities, trade associations, chambers of commerce are increasingly driving technology-based visions, strategies and action plans for local economic development much more so than was visible earlier. Increasingly, higher education leaders, such as Presidents, departmental heads and faculties of science and engineering, representatives of institutional research are increasingly sitting as members and leaders on the councils and boards of these strategic planning processes. Their contribution includes expertise in areas such as curriculum, customized training and lifelong learning, besides technical assistance and problem solving (Plosila 2004).

3.4 The West Virginia EPSCoR Experience

West Virginia, an Appalachian state, was one of the first five states to join the EPSCoR program in 1980 along with Arkansas, Maine, Montana and South Carolina. West Virginia's participation in EPSCoR has enabled the state to stimulate its economic development through research, innovation and emphasis on mathematics and science education from elementary school to graduate study (Manchin and Tomblin 2007). In the last nearly three decades, West Virginia efforts as a result of its participation in the EPSCoR has established this state as a knowledge-driven economy.

Throughout the 1990s, West Virginia has consistently focused on building upon its existing areas of strength, i.e. its petro-chemical industrial complexes and metals industry which both represents the strongest industrial RandD sectors in the state. Besides, the state has also plunged into new but perhaps risky areas of investment, such as information technologies, identification technologies, and workforce development (Calzonetti and Gatrell 2000). In all this, the West Virginia Science and Technology Advisory Council have been very instrumental through the preparation of plans and strategies and also prioritizing the expenditure of funds.

When compared with other 49 states as also the jurisdiction of Puerto Rico and the Virgin Islands, West Virginia fares very low in most SandT measures. On many accounts such as total RandD expenditure, expenditure on academic and industrial RandD, the state has ranked low in the early and mid-1990s. However, with support from EPSCoR and other federal intramural funding in 1995 to the tune of $ 140 million West Virginia now has two major federal research facilities, namely, The Federal Energy

Technology Center (FETC) in Morgantown and The NASA Software Independent Verification and Validation facility in Fairmont. These facilities are high-technology investments leading to an active research participation of the West Virginia University. A yet another new federal addition to West Virginia is the $ 350 million facility, the Federal Bureau of Investigation's (FBI) Fingerprint Identification Center, located at Clarksburg. Its establishment has led to the introduction of instructional programs in identification technologies at the West Virginia University. All this shows that the state is clearly trying to build on areas of existing strength as also trying to develop as a learning region (Calzonetti and Gatrell 2000).

More recently in 2001, the state received a $ 9 million grant from the NSF to improve its state research infrastructure. In 2004, the Governor proposed the creation of a Research Challenge Fund which is overseen by the West Virginia EPSCoR office. The role of West Virginia's EPSCoR has been so critical that as a matter of policy now research is formally integrated into a long-term strategic plan that would guide the state's policy and budgetary actions. Also the State EPSCoR advisory council led the planning process that resulted in a "Vision 2015: West Virginia's Science and Technology Strategic Plan". This vision plan states that by 2015 research and innovation will be the driver of West Virginia's new, diverse and prosperous economy (Manchin and Tomblin 2007).

CHAPTER 4

DATA AND METHODOLOGY

4.1 Background

This section of the study discusses the methodological aspects of the study. In this study of SANDT policy and planning practice states are realizing the significance of knowledge and technology driven economy and the tools that access, direct and use this knowledge are going to be key to any state's economic future. The first section describes the units of analysis and sources of data. The second section explains the SandT metrics or indicators and the dependent variable (RandD as share of gross state product). The use of RandD is a proxy to measure SandT. The third section outlines the statistical procedures and models used for local spatial analysis.

4.2 The Data Units

Two significant units of analysis in this study are states and land grant institutions. Historically, states have been the institutional platforms for organizing any efforts towards technology-based economic development. In the 1960s, many states under the encouragement from the US Department of Commerce and the NSF established the position of Governor's Science Advisor and created a state science and engineering foundation to parallel the President's Science Advisor and NSF federal model (Plosila 2004). Since then state has been the scale at which many federal level support and local initiatives have been ushered, such as the US Department of Commerce's State Technical Services (STS) program which was canceled in 1969, the 1977 Congress sponsored and NSF established the State Science and Engineering and Technology (SSET) Program. Later in the 1980s with the experience of MIT-led Route 128 in Massachusetts, Stanford-led growth of the Silicon Valley and the growth of Research Triangle Park-led by the Duke University and University of North Carolina efforts all led to the emergence of state science and technology programs with direct links to economic development. Over the years, states matured in realizing their role in science and technology-led economic development. While states became a significant platform, universities too began to participate in state led economic development efforts by pooling in their vast resources in such areas as research and development, technology transfer, industrial extension, problem solving and more recently through the formation of technology alliances and trade associations with businesses (Plosila 2004). Thus, in this study the unit of analysis remains both state and land grant institutions. The NSF which also established the EPSCoR program on behalf of the Congress maintains a database of *Science and Engineering Indicators*. NSF compiles this data every two years. These are national rankings by indicators and are ordinal in nature. An example of indicators that NSF covers includes Academic article output per 1,000 SandE doctorate holders in academia, Academic patents awarded per 1,000 SandE doctorate holders in academia, Engineers as share of workforce, SandE doctorate holders as share of workforce, Venture capital deals as share of high-technology business establishments among others. Data are available for 1994, 1998, 2002 and 2004. For the purpose of this study I use aggregated data at the state level, since secondary data is readily available at this scale. Though using data at state scale has a major drawback. Since SandT enterprises tend to be clustered in and around metropolitan areas, aggregating of data at the state scale does not do justice for it cannot take into account the spatial diversity that large states provide.

The use of land grant institutions as a unit of study is both challenging as well as remarkable for it also brings into the picture, the issue of politics of scale. However, the reasons for considering land grant institutions as a unit of analysis were: firstly, given the accelerated role of universities in state level SandT-led economic development processes, and, secondly, readily available data on major land grant institutions through the NSF database. The NSF being a central clearinghouse for the collection, interpretation and analysis of data on scientific and technical personnel in the United States, also conducts in that capacity a Survey of Research and Development Expenditures at Universities and Colleges more popularly known as the *Academic RandD Expenditures Survey*. Here, the key variables for which data is generated are RandD expenditures by source of funds, RandD expenditures by character of work, total and federally funded RandD expenditures among others. These data are interval in nature. With NSF data the only source of error can be in terms of institutional records. The data through the *Academic RandD Expenditures Survey* is available annually. Besides, this study also uses data from such other sources like the Census Bureau to correlate SANDT indicators with socio-economic and demographic variables. Qualitative data mainly in the form of narratives (reports, studies etc.) from EPSCoR, NSF, Small Business Administration, County Business Patterns, State and Regional economic development agencies, and Governor's Science Advisors Office generated reports and studies, are used to explore business climate and socio-spatial linkages.

4.3 Measurements of Indicators

Nearly 26 indicators covering the overall nature of SandT enterprise are examined at the state level, besides about 6 other variables from land grant institutions to understand and answer questions posed. An attempt is made to measure (estimate low and highs, ranks etc.) change over time in SandT enterprise through these indicators and variables (Table 1). In trying to understand the SandT enterprise at the state level, attempt is also made to uncover the spatial specifics of this SandT experience in a place.

4.4 Methods of Analysis

Data analysis in this research would involve both quantitative and qualitative. The quantitative data analysis involves data collection, and collation from the databases of NSF and Census Bureau. There is a need to rank data to understand the change and also to map this data. Besides, simple descriptive (frequency, mean and standard deviation) statistics are also used to understand linkages between industry, government and university and establish the triple helix model. Moreover, this simple ranking of SandT indicators also allows input-output analysis.

The SandT indicators are subjected to correlation analysis to measure and understand the relationship between variables. Thereafter regression analysis is used to investigate the causal relationship between the dependent variable RandD as share of gross state product and other selected independent variables. In the process, 6 regression models are generated both at the scale of states and land grant institutions to understand the performance of these indicators for all states, EPSCoR and non-EPSCoR states. While both correlation and regression give us an understanding of the causal relationship between the dependent variable and other indicators and variables, however, to understand the socio-spatial specifics of SandT indicators in a place, this study employs shift and share analysis method, wherein employment data shall be examined at the state level to understand local growth and change. This method uses a baseline value (known as national growth component) to understand expected employment growth in identified sectors. This method uses an industrial mix component which adds or subtracts a job change value that accounts for the state's unique industrial mix. Thereafter a third component called competitive share adds or subtracts a job change value reflecting the competitiveness of local employment sectors within the state. Finally, a sum of these three components equals total employment change in the county during the period measured. Thus, there are three uses of shift-share analysis, namely, forecasting, strategic planning and policy evaluation.

Table 4.1

Table of Indicators and Variables

Unit of Analysis	Indicators
States	Academic article output per 1,000 SandE doctorate holders in academia
States	Academic article output per $1 million of academic RandD
States	Academic patents awarded per 1,000 SandE doctorate holders in academia
States	Academic RandD per $1,000 of gross state product
States	Advanced SandE degrees as share of SandE degrees conferred
States	Average undergraduate charge at public 4-year institutions
States	Bachelor's degree holders as share of workforce
States	Computer specialists as share of workforce
States	Elementary and secondary public school current expenditures as share of gross state product
States	Employment in high-technology establishments as share of total employment
States	Engineers as share of workforce
States	High-technology share of all business establishments
States	Individuals in SandE occupations as share of workforce
States	Industry-performed RandD as share of private-industry output
States	Life and physical scientists as share of workforce
States	Net high-technology business formations as share of all business establishments
States	Patents awarded per 1,000 individuals in SandE occupations
States	RandD as share of gross state product
States	SandE degrees as share of higher education degrees conferred
States	SandE doctorate holders as share of workforce
States	SandE doctorates conferred per 1,000 SandE doctorate holders
States	SandE graduate students per 1,000 individuals 25–34 years old
States	State expenditures on student aid per full-time undergraduate student
States	Venture capital deals as share of high-technology business establishments
States	Venture capital disbursed per venture capital deal
States	Venture capital disbursed per $1,000 of gross state product

Source: NSF – Science and Engineering Indicators

Table 4.2

Variables by Institutions as Units of Analysis

Unit of Analysis	Variables
Institutions	RandD expenditures by source of funds (federal, state and local, industry, institutional, or other)
Institutions	RandD expenditures by character of work (basic research vs. applied research and development)
Institutions	RandD expenditures passed through to sub-recipients
Institutions	RandD expenditures received as a sub-recipient
Institutions	Total and federally-funded RandD expenditures by SandE fields
Institutions	Total and federally-funded RandD expenditures by non-SandE fields (optional prior to FY 2003)
Institutions	Total and federally-funded RandD equipment expenditures by SandE fields
Institutions	Federally-funded expenditures by SandE field and federal agency (optional prior to FY 2003)
Institutions	Academic institution/FFRDC
Institutions	Institutional characteristics (highest degree granted, historically black college or university (HBCU), public or private control)
Institutions	FFRDC characteristics (academic, nonprofit, or industrial)
Institutions	Geographic location (within the United States)

Source: NSF - Survey of Research and Development Expenditures at Universities and Colleges

4.5 Description of Indicators

AAOadj: Academic Article Output per $1 million of academic RandD by state (adjusted)

Drawn from the NSF's Science and Engineering Indicators directory, this indicator shows the relationship between the number of academic articles published and the expenditure on academic RandD. A high value attached to this indicator would signify that the state's academic institutions (both 2 year and 4 year schools) have higher publication output relative to their RandD spending. However, this indicator would also be relative to the publishing conventions in different disciplines and the variable costs of conducting research across disciplines, besides the difference in expectations of different institutions to publish. For the purpose of comparison, this indicator was adjusted according to consumer price index (CPI index) as published in the Annual Economic Report of the President to contain inflation over time.

ARandDadj: Academic RandD per $1,000 of gross state product, by state (adjusted)

This indicator, also drawn from the NSF's Science and Engineering Indicators directory is a measure of the magnitude of spending on academic research performed in a state relative to the size of its economy which is expressed in terms of its gross state product (). A clear distinction between academic RandD and industry RandD is that academic RandD is more basic in nature and contributes to the future economic development of the state. A high score on this indicator reflects that a state can be more competitive while seeking financial support from other sources to augment its overall RandD capacity. Since this indicator is also expressed in terms of dollar value it is adjusted (inflated or deflated) to contain inflation over time based upon the CPI index as published in the Annual Economic Report of the President.

ADVSandE: Advanced SandE degrees as share of SandE degrees conferred, by state

Advanced science and engineering (SandE) degrees as share of SandE degrees conferred is an indicator reflecting the level of higher education by way of the extent to which a state's higher education program in SandE disciplines are focused at the graduate level.

Examples of SandE disciplines are physical, life, earth, ocean, atmospheric, computer, and social sciences; mathematics; engineering and psychology. Typically advanced degree in SandE includes masters and doctorates. All SandE advanced degrees also include the bachelor's degree, but it excludes associate's degree. A high value of this indicator demonstrates the emphasis of the state on SandE training at the graduate level.

AVGUGadj: Average undergraduate charge at public 4-year institutions, by state (adjusted)

This indicator is a measure of affordability of higher education at a public educational institution for the average resident population. This indicator is calculated by dividing the average undergraduate charge of the sum total of the public four year institutions fee in the state by the per capita personal disposable income of state residents. This undergraduate charge includes among others standard in-state tuition, room, board, and required fees for a student who is a resident of the state. A high value of the undergraduate charge means that undergraduate education was more costly and less affordable to the state residents and this amount does not include any adjustments that the student may receive as a recipient of any financial aid. Since this indicator is also expressed in terms of dollar value it is adjusted (inflated or deflated) to contain inflation over time based upon the CPI index as published in the Annual Economic Report of the President.

BWF: Bachelor's degree holders as share of workforce, by state

This indicator displays the available population with a bachelor's degree and above for its workforce. It is the ratio of those holding a bachelor's, graduate, or professional degree to the size of the state's workforce. A higher value of this indicator simply indicates that a large percentage of the potential workforce with an undergraduate education is available. It certainly does not mean that all those with a bachelor's degree and above are employed. Those in the business of science and technology related activity would look at a state favorably with a high value attached to this indicator for it would mean more population available between the age group of 25-64 with a bachelor's degree and above.

SandEHED: SandE degrees as share of higher education degrees conferred, by state

This indicator is an estimate of the extent to which a state's higher education programs are concentrated in SandE fields such as physical, life, earth, ocean, atmospheric, computer, and social sciences; mathematics; engineering; and psychology. A higher value of this indicator (expressed in percentage) shows that a state emphasizes on science and engineering fields in their higher education systems. This indicator reflects the geographic location of the state through the institution and not that of the student.

SandEGRAD: SandE graduate students per 1,000 individuals 25–34 years old, by state

This indicator displays the ratio of SandE graduate students to a state's 25–34-year-old population with graduate training in SandE. The 25–34-year-old cohort was chosen since most graduate students belong to this age group and also includes noncitizens and students from other states. NSF collected this data from all academic institutions in the United States offering Master's and doctoral degrees in any science or engineering field, including physical, life, earth, ocean, atmospheric, computer, and social sciences;

mathematics; engineering; and psychology but did not include schools of nursing, public health, dentistry, veterinary medicine, and other health-related disciplines.

TimeD: Time Dummy

Time Dummy is a pooling metric created in a pool-time series like this study for it serves to control for variance within and between the annual data sets.

FFRandDExpatUCadj: Federally Financed Research and Development Expenditures at University and Colleges (Adjusted)

This indicator is about data collected on separately budgeted RandD expenditures in science and engineering (SandE) related research and development reported by universities and colleges. The source of this data is the NSF's Survey of Research and Development Expenditures at Universities and Colleges (Academic RandD Expenditures Survey). Since this indicator is also expressed in terms of dollar value it is adjusted (inflated or deflated) to contain inflation over time based upon the CPI index as published in the Annual Economic Report of the President.

RandDExpatUCadj: Research and Development Expenditures at Universities and Colleges (Adjusted)

This indicator shows the RandD expenditures at universities and colleges for basic and applied research in SandE fields. The source of this data is the NSF's Survey of Research and Development Expenditures at Universities and Colleges (Academic RandD Expenditures Survey). Since this indicator is also expressed in terms of dollar value it is adjusted (inflated or deflated) to contain inflation over time based upon the CPI index as published in the Annual Economic Report of the President.

TotpopinM: Total Population (in Millions)

This variable provides data of the total household population at the scale of the state from the US census bureau of 1990 and 2000. For the purpose of this study the data is expressed in millions.

PropFB: Proportion of Foreign Born

This variable is by definition that section of the US population which is not a U.S. citizen at birth. This includes naturalized U.S. citizens, lawful permanent residents (immigrants), temporary migrants (such as foreign students), humanitarian migrants (such as refugees), and persons illegally present in the United States. The data is expressed in terms of proportion of total population.

PopLessHSD: Proportion of Population with High School Diploma or lesser

This variable includes population 16 years and older with a diploma from a high school or with either the ninth through the twelfth grade or the tenth through the twelfth grades.

PopSomeCorA: Proportion of Population with some College or Associateship

This variable provides state level data for proportion of population with some College or Associateship.

ProppopBachlor: Proportion of Population with Bachelor's degree

This variable provides state level data for proportion of population with Bachelor's degree.

ProppopGradProf: Proportion of Population with graduate/ professional degree

This variable provides state level data for proportion of population with graduate/ professional degree.

Propemply16above: Proportion of Employed Population 16 years and above

This variable provides state level data for proportion of population 16 years and above and employed.

PropPrimary: Proportion of Employed Population 16 years and above in Primary Sector

This variable was constructed by adding the census data on proportion of employed population 16 years and above in agriculture, forestry, fishing, hunting and mining.

PropSecondary: Proportion of Employed Population 16 years and above in Secondary Sector

This variable was constructed by adding the census data on proportion of employed population 16 years and above in construction and manufacturing.

PropTertiary: Proportion of Employed Population 16 years and above in Tertiary Sector

This variable was constructed by adding the census data on proportion of employed population 16 years and above in wholesale trade, retail trade, transportation and warehousing and utilities.

PropQuaternary: Proportion of Employed Population 16 years and above in Quaternary Sector

This variable was constructed by adding the census data on proportion of employed population 16 years and above in information and finance, insurance and real estate, professional, scientific and management, as also the educational, healthcare and social services.

PropQuinary: Proportion of Employed Population 16 years and above in Quinary Sector

This variable was constructed by adding the census data on proportion of employed population 16 years and above in the arts, entertainment and recreation and other nonprofit(s) sector except public service.

MedHHIadj: Median Household Income (Adjusted)

Since median household income is expressed in terms of dollar value, it was constructed by adjusting (inflating or deflating) the median household income at the state level to contain inflation over time based upon the CPI index as published in the Annual Economic Report of the President.

PercapitaINadj: Per Capita Income (Adjusted)

Since per capita income is expressed in terms of dollar value, it was constructed by adjusting (inflating or deflating) the per capita income at the state level to contain inflation over time based upon the CPI index as published in the Annual Economic Report of the President.

Propvacanthousing: Proportion of Vacant Housing Units

This variable provides state level data for proportion of vacant housing units.

MedHouseValueadj: Median Housing Value (Adjusted)

Since median housing value is expressed in terms of dollar, it was constructed by adjusting (inflating or deflating) the median housing value at the state level to contain inflation over time based upon the CPI index as published in the Annual Economic Report of the President.

CHAPTER 5

SPATIAL DISTRIBUTION OF SANDT INDICATORS: ANALYSIZING EPSCOR STATES

5.1 Ranking Analysis

As shown in Table 5.1 when compared to the Non-EPSCoR states, the EPSCoR Foundation, states performance on most selected SANDT indicators is not strong (National Science 2008 and 2006). In 1995, most EPSCoR states (*shaded*) ranked on the bottom 10, across indicators such as RandD as share of GDP, science and engineering doctorates conferred per 1,000 SandE doctorate holders, patents awarded per 1,000 individuals in SandE occupations, by state and venture capital disbursed per $ 1,000 of gross domestic product. The significance of studying these indicators through their national ranking, review in terms of change in status and comparisons with other select indicators, provides us insights into the gap between the input (RandD expenditure) and output (Ph.D's produced, patents generated and venture capital disbursed) of select SandT indicators. Between 1995 and 2005, the overall change in the status of EPSCoR's SandT indicators was minimal. In spite of the support from EPSCoR program these states have not displayed much stimulation in their growth. An observation of these indicators suggests that nearly 54% of the EPSCoR jurisdictions never performed at the top 10 level on any of the selected indicators (Table 5.1.1). Interestingly, none of the states which joined the EPSCoR program in cohort one, i.e. the year 1980 has performed well enough to be in the top 10 for the selected indicators.

Table 5.1.1

Ranking of Important SandT Indicators in 2005 (Shaded are EPSCoR)

RD as Share of GDP		SE Doctorates Conferred per (1000 SE Doctorate Holders)		Patents awarded per 1,000 individuals in SandE occupations		Venture Capital Disbursed per $1,000 of Gross Domestic Product	
Top Ten (%)		Top Ten (Per 1000)		Top Ten (Per 1000)		Per $ 1000	
NM	8.01	IA	61.8	VT	34.2	MA	8.51
MD	6.26	IN	60.3	OR	31.9	CA	7.28
MA	5.17	MI	54.3	CA	30.5	WA	3.51
MI	4.6	LA	53.7	MN	23.5	CO	2.79
RI	4.36	RI	53.2	NH	21.7	MD	2.55
WA	4.33	KS	50.9	CT	20.8	RI	2.49
CN	4.29	NE	50	MA	20.2	NJ	1.72
CA	3.93	GA	49.8	WA	19.1	UT	1.72
NH	3.22	IL	49.7	NY	18.3	PA	1.50
DC	3.06	AK	47.7	MI	18.0	NC	1.36
Bottom Ten	Percent	Bottom Ten	Per 1000	Bottom Ten	Per 1000	Bottom Ten	Percent
MS	0.85	WA	24.9	WV	6.0	WV	0.07
AK	0.78	OR	23.9	NE	5.7	LA	0.06
KY	0.76	MT	23.8	AR	5.6	AL	0.00
OK	0.73	PR	23.7	AL	5.4	DE	0.00
AR	0.63	DC	22.3	MS	4.8	ID	0.00
NV	0.63	AK	18.8	HI	4.4	IA	0.00
LA	0.6	VT	17.9	VA	4.3	MT	0.00
SD	0.5	NM	17.7	AK	3.4	ND	0.00
WY	0.41	ID	17.6	DC	1.0	SD	0.00
PR	.	ME	8.2	PR	1.0	PR	.

Even after twenty-five years of joining the EPSCoR program states, such as Arkansas, Maine, Montana, South Carolina and West Virginia have not become competitive enough to be ranked in the top ten performing states with regard to the selected indicators though they appear in the bottom ten less frequently. However, some states of cohort 2, i.e. those that joined the EPSCoR program in 1985, such as Alabama, Nevada, Vermont and Wyoming do appear ranked in the top ten. Louisiana and Nebraska which joined the program in 1987 and 1992, respectively too made it to the top ten for their performance in production of science and engineering doctorates. Kansas too has remained on the top ten throughout for the same. Among the non-EPSCoR states it could be observed that California and Michigan maintained their status as high performing and high growth states with respect to these indicators.

A review of Tables 5.1.1 and 5.1.2 with regards to change and growth in RandD as share of GDP among EPSCoR states demonstrates that New Mexico and Rhode Island were the only two states that figured among the top ten both in 1995 and 2005. With respect to science and engineering doctorates conferred per 1,000 SandE doctorate holders, among the EPSCoR states it was observed that Rhode Island and Kansas too stayed in the top ten both in 1995 and 2005. If we add Rhode Island's 6th rank with respect to venture capital disbursed per $ 1,000 of gross domestic product, then, clearly there is a trend for Rhode Island to emerge as a strong performing EPSCoR state across three out of four indicators. Unlike many others, Rhode Island was a latecomer into the EPSCoR program and yet its performance shows promise and great expectations which is also because of its geographic proximity to Boston, Massachusetts and the Route 128 technology corridors. Other states such as South Dakota, Louisiana, Wyoming, Mississippi, Arkansas, Kentucky, Alaska and North Dakota stayed among the bottom ten performing states. But for Wyoming, all the other states among the bottom ten registered a growth in their RandD share even though the growth was marginal.

Table 5.1.2

Ranking of Selected SandT Indicators in 1995 (Shaded States are EPSCoR)

Ranking for RandD as Share of GDP		SE Doctorates Conferred per (1000 SandE Doctorate Holders)		Patents Awarded per 1,000 Individuals in SandE occupations		Venture Capital Disbursed per $1,000 of GSP, by state	
NM	7.81	IA	120.6	NH	32.9	MA	3.51
DC	6.46	RI	105.3	CT	31.1	CO	3.04
MI	5.22	IN	94.9	DE	30.9	CA	3.03
MA	5.05	AZ	84.9	MN	28.0	WA	2.18
MD	4.92	WI	78.9	WI	27.2	VA	1.44
DE	4.17	UT	76.1	NY	26.7	TN	1.28
CA	3.89	MI	76.0	MI	26.1	MN	1.24
CT	3.63	IL	75.7	NJ	25.8	NC	1.13
RI	3.49	KS	74.8	IL	25.2	CT	1.07
WA	3.46	MA	72.3	IN	25.0	NJ	1.05
Bottom Ten	Percent	Bottom Ten	Per 1000	Bottom Ten	Per 1000	Bottom Ten	Percent
MT	0.68	MO	31.5	KS	10.8	ME	0.05
ND	0.67	VT	31.3	AR	10.1	MS	0.05
AS	0.66	NJ	28.7	NE	9.8	NV	0.01
KY	0.65	NM	28.2	VA	9.0	AK	0.00
AR	0.61	ID	25.8	AL	8.8	DC	0.00
MS	0.58	DC	25.3	MS	8.8	HI	0.00
WY	0.58	SD	21.5	SD	8.1	MT	0.00
HI	0.45	NV	17.4	AK	7.4	SD	0.00
LA	0.38	ME	16.4	HI	6.4	WV	0.00
SD	0.30	AK	9.5	DC	1.2	WY	0.00

An examination of science and engineering doctorates conferred per 1,000 SandE doctorate holders shows that both Kansas along with Rhode Island remained among the top ten performing states though there was a marginal decline in their absolute performance. Kansas declined from 74.8 in 1995 to 50.9 in 2005, while Rhode Island declined from 105.3 in 1995 to 53.2 in 2005 in terms of total number of science and engineering doctorates conferred per 1,000 SandE doctorate holders. Even the top performing non-EPSCoR states such as Michigan too registered a decline from 76 in 1995 to 54.3 in 2005. States such as Alabama, Louisiana and Nebraska also appeared in the top ten performers though they were not the same in 1995. Apart from Arkansas which registered an increase in its performance with regard to production of SandE doctorates, most states which remained among the bottom ten performing cohort also witnessed a marginal decline in their production of SandE doctorates. An analysis of data on patents awarded per 1,000 individuals in SandE occupations shows no clear pattern of increase in performance by EPSCoR states. In 1995, states such as Delaware, New Hampshire made it to the top ten and while New Hampshire reappeared in 2005 among the top ten, Delaware slipped out. Vermont which joined the EPSCoR program in 1985 was not among the top ten performing states in 1995 but figured in 2005. With regard to both New Hampshire and Rhode Island's performance on indicators, such as patents generated and production of doctorates in and among the New England states it can be safely observed that these EPSCoR states are getting close to closing the gap between input and output SandT metrics. In so much they mirror the observed high performance of states such as California, Massachusetts and Michigan among many others. Among the eight EPSCoR states (Hawaii, Alaska, South Dakota, Mississippi, Alabama, Nebraska, Arkansas and Kansas) which appeared among the bottom ten in 1995 with regard to patents awarded, six resurfaced among the bottom ten in 2005 except for South Dakota and Kansas, though each one of the states which resurfaced had reduced their numbers of patents awarded. In other words, both South Dakota and Kansas improved their number of patents awarded from 1995.

Among output indicators venture capital disbursed per $ 1,000 of gross domestic product is a significant indicator that represents an important source of funding for startup companies. This indicator shows the relative magnitude of venture capital investments in a state after adjusting for the size of the state's economy. With regard to this indicator when EPSCoR states were examined, 9 states were among the bottom ten in 1995. These states were Maine, Mississippi, Nevada, Alaska, Hawaii, Montana, South Dakota, West Virginia and Wyoming. While Maine, Mississippi and Nevada had some venture capital investments in 1995, these were on the lower side. These states improved their numbers in 2005. West Virginia which had no venture capital disbursement up until 1995, raised its numbers far enough to stay above the bottom ten states in 2005. Interestingly, Wyoming a state which did not have any record of venture capital disbursement until 1995, too, raised its numbers far enough to stay above the bottom ten states in 2005. The better performing EPSCoR state in 1995 was Tennessee. Though its performance declined in 2005, Rhode Island meanwhile picked up by appearing in the top ten in 2005. Even among the non-EPSCoR cohort, the high performing states such as California and Massachusetts's capacity to increase their numbers were limited. However, North Carolina raised its numbers from 1995 to 2005, though marginally.

When examining change in few such indicators as well as the dependent variable (ARandD), one can see the difference from 1993-94 to 2003-04, and as has been indicated in the choropleth maps (Figure 5.1). Based upon a ranking of all states for

ARandD, the dependent variable in 1993-94 as well as 2003-04, one can see the color difference in case of few such states that have climbed up the ranks. For example, in 1993-94, Ohio, Illinois, Indiana, Kentucky, Tennessee, and Mississippi were all in the 2nd category based upon their performance. In 2003-04, though, these states slipped up the 3rd category of performance for ARandD. In case of mountain states such as North Dakota and Montana, too, their ranks have improved from 4th and 3rd towards 5th in performance. Likewise the Northeastern states of Vermont, New Hampshire, Maine, and Pennsylvania have risen up in the ranks as can be seen from the colors in the maps. The patterns of change in ARandD that emerge in different states, and how these can be explained by the existing spatial policies initiated by the federal government are among some of the questions the answers to which will be explored in the forthcoming sections.

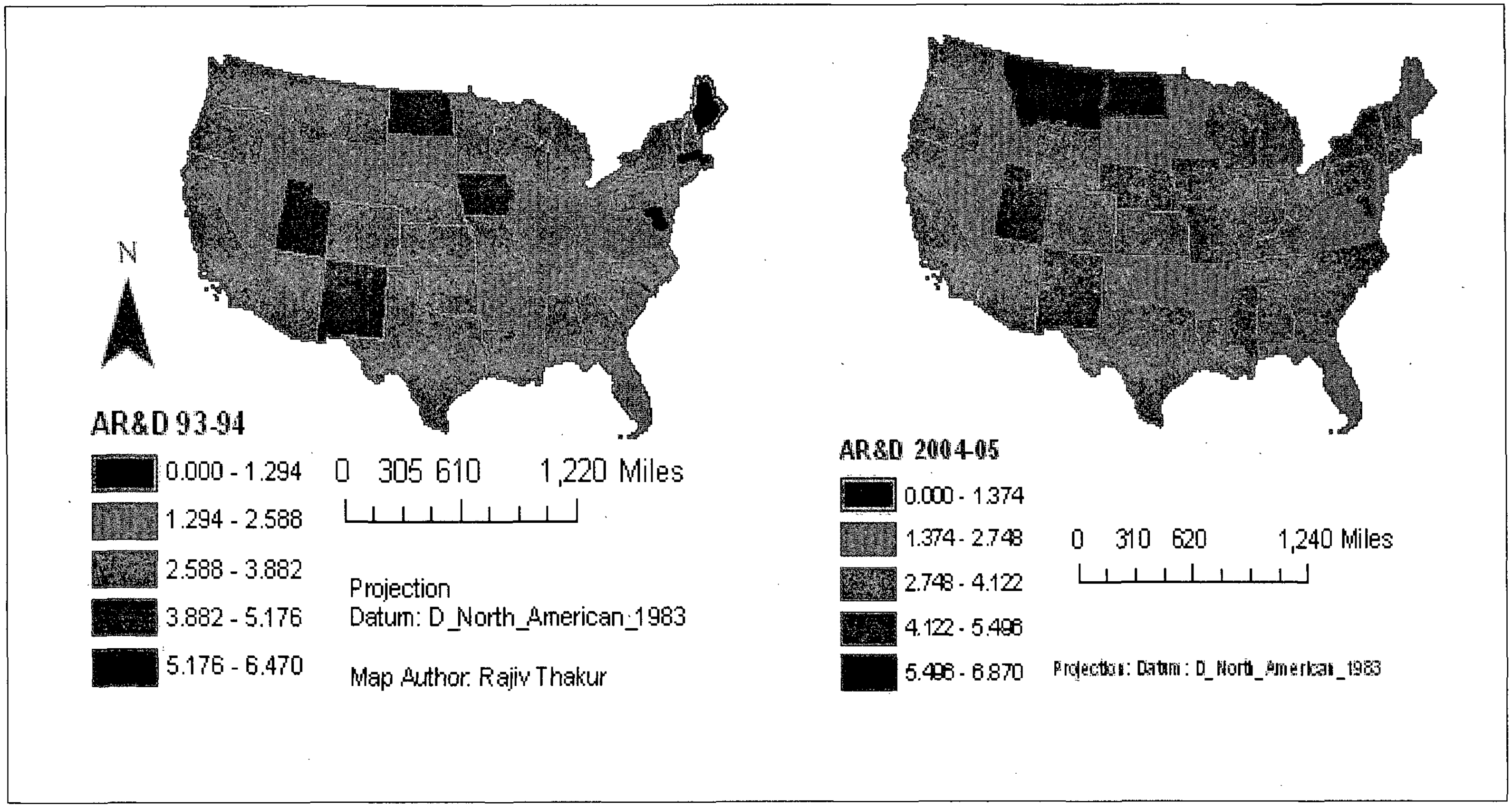

Figure 5.1: Comparative maps for ARandD in 1993-94 and 2004-05 for all states

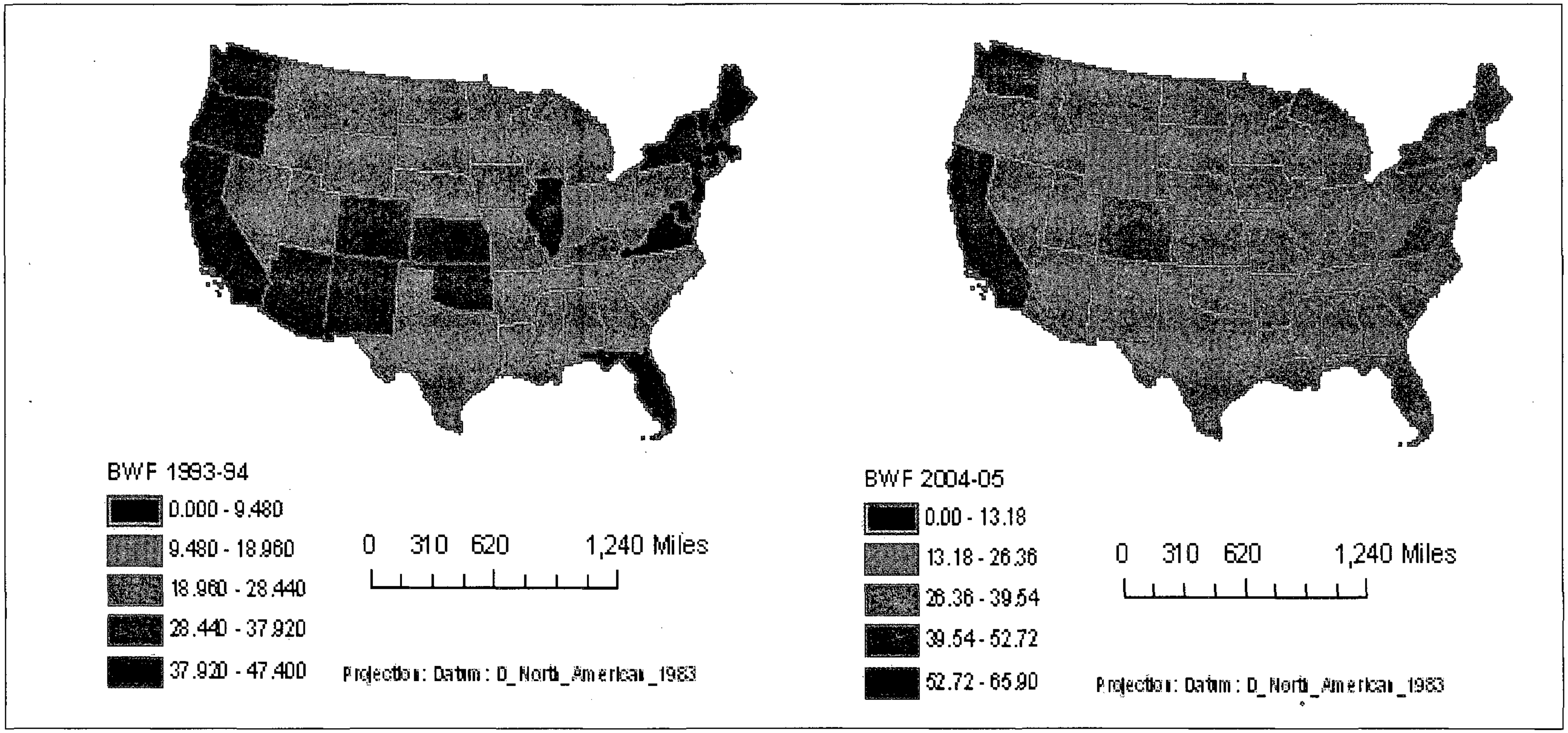

Figure 5.2: Comparative maps for BWF in 1993-94 and 2003-04 for all states

Figure 5.2 highlights a comparison for the variable "BWF" in 1993-94 against 2003-04. It is evident that, many of the West coast and Mountain region states for example, Arizona, Oregon, and New Mexico have shown negative trend. Few Mid-Western states, though, have shown positive developments as they gained in their rank from the 2nd category rank in 1993-94 to 3rd category in 2003-04. Other more developed states, such as Florida, New York, and Illinois, though, have dropped down the ladder on this variable. Under a generalist assumption, a negative relationship between ARandD and BWF does not make much sense, though this may be indicative of certain other processes that are hindering the assumed relationship between the dependent variable "ARandD" and the independent variable "BWF".

Likewise, a visual analysis of two maps (Fig 5.3) for SandEHD indicator for 1993-04 and 2003-04 highlights a positive development towards betterment through the decade. Many of the West coast states, such as Washington, Nevada, and New Mexico, Mountain states, such as Montana and Wyoming, Mid-Western states, such as North Dakota and Missouri, North-Eastern states, such as Virginia and Massachusetts, and Southern states, such as North Carolina and Mississippi have climbed up the ladder by few stages, i.e. from category 3rd to 4th or from category 4th to 5th.

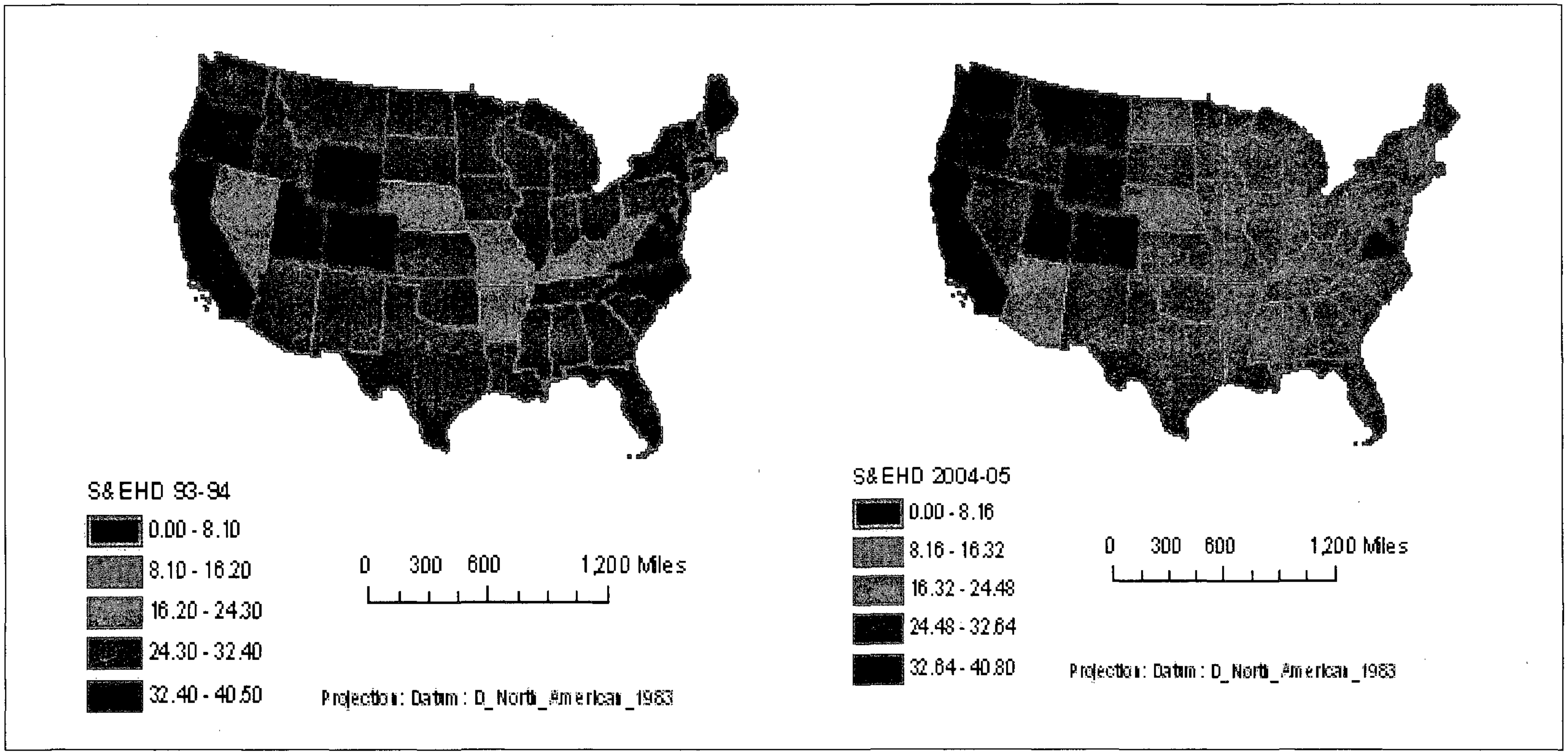

Figure 5.3: Comparative maps for SandEHD in 1993-94 and 2003-04 for all states

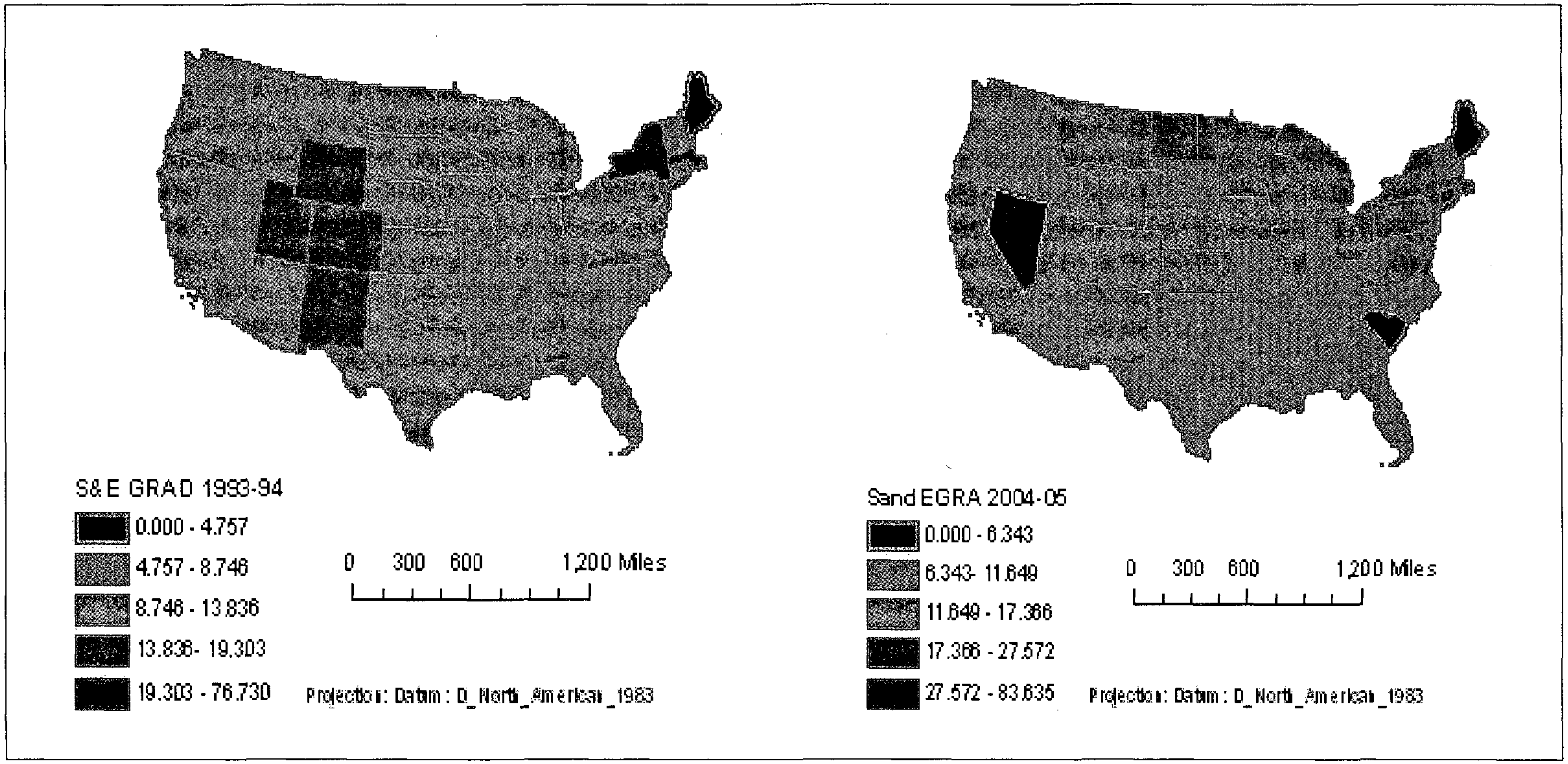

Figure 5.4: Comparative maps for SandEGRAD in 1993-94 and 2003-04 for all states

Considering the variable of Science and Engineering Graduates from 1993-94 to 2003-04, one can see the mixed patterns in many of the states are discernible. While many states show a positive trend of development though the decade, others have dropped down in the categorization indicated in the map (Fig 5.4). For example, the states of Oregon, Idaho, Utah, Colorado, New Mexico, Wyoming, Texas, Oklahoma, South Dakota, Alabama, Indiana, South Carolina, New York, and South Carolina have shown declining patterns on this indicator. The only states that have shown positive trend are Nevada, Arizona, and North Dakota. Rest of the states have maintained status quo.

The patterns indicated by these variables with regards to the dependent variable ARandD can also be assessed by comparing the same on maps. For example, the states ranking higher categories have also high ranked categories in the variables BWF, SandEHD, and SandEGRAD for 2003-04 (Fig 5.5). This is also explained by high correlations of ARandD with these three variables BWF, SandEHD, and SandEGRAD. The following sections further discuss these relationships with the dependent variable ARandD as well as among the explanatory variables.

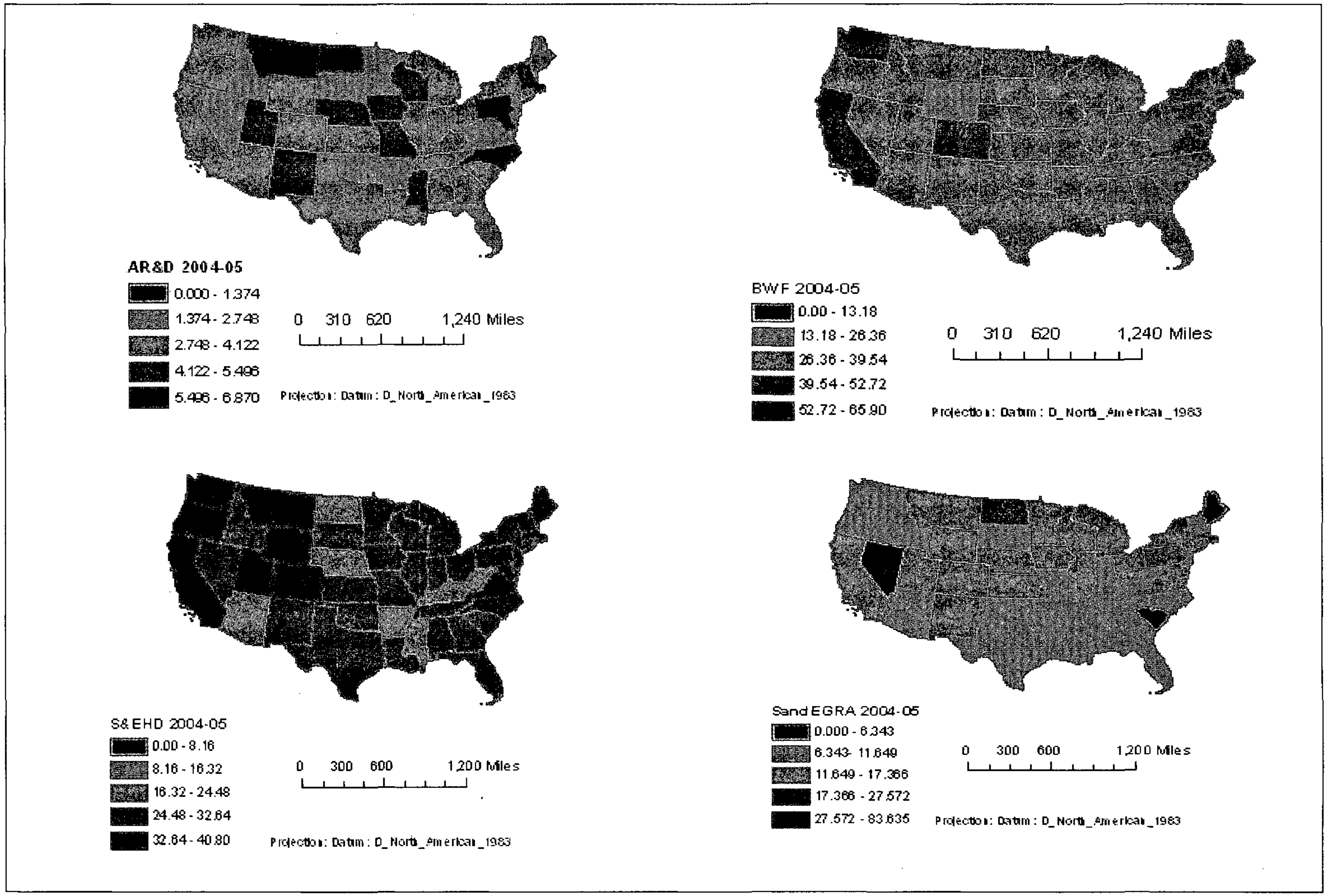

Figure 5.5: Comparison of ARandD against BWF, SandEHD, and SandEGRAD in 2004-05.

5.2 Correlation Analysis

In the previous section o this chapter science and technology indicators of this research were ranked at the state and land grant scale to examine their uneven distribution. However, to further analyze the metrics of SandT, particularly the gap if any, between input SandT metrics (expenditures) and output SandT metrics (patents), science and technology indicators and socio-economic and demographic variables were subjected to correlation (Pearson's R) and regression analysis (ordinary least squares regression and stepwise backward approach). Correlation analysis was performed for the following two reasons firstly, to determine the statistical association between any two indicators/variables at the state and land grant institutions scales, and secondly, to determine in particular the statistical association between Academic RandD per $1,000 of gross state product, by state (adjusted) (ARandDadj) and all other selected indicators and variables.

5.2.1 Correlations for States

The results of correlation analysis using Pearson's R between the selected SandT indicators and socio-economic and demographic data are shown in Table 5.2.1. Overall, the Pearson's correlation table demonstrates very low degree but positive relationship between the indicator ARandDadj and other SandT indicators, as also the socio-economic and demographic variables for all states. In performing correlation analysis outcomes were also compared between results from all states, to EPSCoR and non-EPSCoR states to understand the differences, if any, between them.

The correlation between ARandDadj and AAOadj (Academic Article Output per $ 1 million of academic RandD by state (adjusted)) for all states (Table 5.2.1) is -0.012 which is a value close to zero, indicates a weak association between the indicators. When correlation between ARandDadj and AAOadj for EPSCoR states was conducted, it was found that the Pearson's 'r' value was -0.16 (Table 5.2.2) indicating same weak association as with all EPSCoR states too. Even in the case of non-EPSCoR states the correlation was 0.06 [Table 5.2.3] thus establishing a weak association between ARandDadj and AAOadj at the state scale.

Similarly, the correlations between ARandDadj and AVGUGadj [Average undergraduate charge at public 4-year institutions, by state (adjusted)] for all states is positive but the low value of association at 0.11 demonstrates a markedly low degree of association indicating that as AVGUGadj increases so does the percent share of ARandDadj. Correlation results between ARandDadj and AVGUGadj at the level of EPSCoR states were nearly the same, i.e. 0.18 (Table 5.2.2) as also in the case of non-EPSCoR states at -0.08 (Table 5.2.3) thus indicating a very low degree of association.

When examining the association between ARandDadj and BWF (Bachelor's degree holders as share of workforce, by state) for all states, it was found that the correlation coefficient or 'r' was 0.2 and the significance was at 0.05 level. This indicates that the association is very low and while being positive, it also demonstrates that an increase in BWF would lead to an increase in the percent share of ARandDadj. The correlation at the level of EPSCoR states between ARandDadj and BWF at 0.34** [Table 5.2.2] was also low positive. However, when the same association was examined between ARandDadj and BWF at the level of non-EPSCoR states it was found to be 0.03

Table 5.2.1

Pearson Correlations for All States

Variables	ARandD adj	AAO adj	ADVS andE	AVGUG adj	BWF	Sand EHED	Sand EGRA D	Time Dumm y	Totpop inM	PropFB	Proppop LessH SD	Proppop Some CorA	Proppop Bachlo r	Proppop GradP rof	Propempl y 16abo ve	Prop Prim	Prop Sec.	Prop Quat.	Med HHlad j	Vac HH	MedHH Valadj
ARandDadj	1																				
AAOadj	-0.01	1																			
ADVSandE	0.23 **	-0.12	1																		
AVGUGadj	0.11	-0.24 **	0.08	1																	
BWF	0.2 *	-0.31 **	0.48 **	0.64 **	1																
SandEHED	0.26 **	0.01 2	0.29 **	0.36 **	0.54 **	1															
SandEGRAD	0.24 **	0.01	0.61 **	0.19 *	0.56 **	0.39 **	1														
TimeDummy	-0.09	-0.84 **	0.08	0.45 **	0.43 **	0.01	0.06	1													
totpopinM	-0.06	0.04	0.17 *	0.22 **	0.16 *	0.06	-0.09	0.05	1												
PropFB	-0.014	-0.21 *	0.38 **	0.41 **	0.61 **	0.29 **	0.19 *	0.31 **	0.59 **	1											
ProppopLessHSD	-0.15	0.68 **	-0.24 **	-0.43 **	-0.65 **	-0.35 **	-0.23 **	-0.76 **	-0.05	-0.5 **	1										
ProppopSomeCorA	0.01	-0.61 **	-0.04	-0.01	0.04	-0.001	-.22**	0.55 **	-0.04	0.17 *	-0.74 **	1									
ProppopBachlo	0.22 **	0.23 **	0.3 **	0.2	0.512 **	0.58 **	0.4 **	-0.24 **	0.058	0.29 **	-0.16 *	-0.2 *	1								
ProppopGradProf	0.23 **	-0.34 **	0.55 **	0.73 **	0.91 **	0.49 **	0.68 **	0.49 **	0.09	0.55 **	-0.65 **	0.01	0.45 **	1							
Propemply16above	0.26 **	0.71 **	-0.06	-0.28 **	-0.28 **	0.08	0.01	-0.79 **	-0.1	-0.25 **	0.43 **	-0.32 **	0.06	-0.29 **	1						
PropPrimary	-0.01	0.07	-0.18 *	-0.56 **	-0.51 **	-0.08	-0.14	-0.29 **	-0.33 **	-0.48 **	0.21 **	0.19 *	-0.21 **	-0.51 **	0.31 **	1					
PropSecondary	0.02	0.67 **	-0.37 **	-0.23 **	-0.53 **	-0.27 **	-0.32 **	-0.64 **	0.05	-0.42 **	0.68 **	-0.47 **	-0.224 **	-0.52 **	0.66 **	0.02	1				
PropQuaternary	0.22 **	0.57 **	0.309 **	-0.1	0.144	0.25 **	0.32 **	-0.65 **	0.07	0.22 **	0.22 **	-0.34 **	0.27 **	0.09	0.77 **	-0.01	0.3 **	1			
MedHHIadj	0.14	-0.19 *	0.29 **	0.6 **	0.607 **	0.47 **	0.12	0.32 **	0.175 *	0.57 **	-0.55 **	0.21 *	0.529 **	0.57 **	-0.24 **	-0.49 **	-0.42 **	-0.01	1		
vacanthousing	-0.11	-0.02	0.12	0.15	0.11	-0.08	-0.13	0.11	0.88 **	0.5 **	-0.05	-0.01	-0.08	0.06	-0.13	-0.33 **	0.04	0.03	0.05	1	
MedHouseValueadj	0.12	-0.27 **	0.31 **	0.51 **	0.73 **	0.47 **	0.29 **	0.39 **	0.26 **	0.78 **	-0.59 **	0.15	0.359 **	0.68 **	-0.2 *	-0.46 **	-0.42 **	0.17 *	0.69 **	0.11	1

Table 5.2.2

Pearson Correlations for EPSCoR States

Variable	ARandD adj	AAO adj	ADVS andE	AVGUG adj	BWF	Sand EHED	Sand EGRAD	Time Dummy	Totpop inM	PropFB	Proppop LessHSD	Proppop SomeCor.	Proppop Bachlor	Proppop GradProf	Propempl 16above	Prop. Prim	Prop. Sec.	Prop Quat.	Med HHladj	Vac HH	MedHH Valadj
ARandDadj	1																				
AAOadj	-0.16	1																			
ADVSandE	25*	-0.32**	1																		
AVGUGadj	0.18	-0.19	-.24*	1																	
BWF	0.34**	-0.41**	0.11	0.56**	1																
SandEHED	0.17	-0.03	0.13	0.38**	0.39**	1															
SandEGRAD	0.49**	-0.15	0.34**	-0.07	0.23*	0.17	1														
TimeDummy	0.01	-0.8**	0.14	0.41**	0.56**	0.03	0.15	1													
totpopinM	-0.21	-0.03	-0.03	-0.28*	-0.18	-0.55**	-0.35**	0.09	1												
PropFB	0.06	-0.25*	0.29*	0.25*	0.46**	0.11	0.09	0.3**	-0.19	1											
ProppopLessHSD	-0.26*	0.71**	-0.27*	-0.419**	-0.66**	-0.33**	-0.36**	-0.75**	0.33**	-0.45**	1										
ProppopSomeCorA	0.14	-0.71**	0.4**	0.06	0.32**	0.19	0.32**	0.61**	-0.31**	0.33**	-0.88**	1									
ProppopBachlor	0.23*	0.27*	-0.01	0.19	0.22	0.52**	0.14	-0.36**	-0.39**	0.11	-0.03	-0.09	1								
ProppopGradProf	0.35**	-0.45**	0.2	0.7**	0.84**	0.33**	0.29*	0.66**	-0.2	0.45**	-0.72**	0.36**	0.13	1							
Propemply16above	0.18	0.67**	-0.092	-0.196	-0.34**	0.077	0	-0.75**	-0.3**	-0.19	0.35**	-0.27*	0.144	-0.32**	1						
PropPrimary	0.08	0.09	0.12	-0.48**	-0.42**	0.17	0.34**	-0.32**	-0.39**	-0.43**	0.062	0.209	-0.01	-0.44**	0.36**	1					
PropSecondary	-0.09	0.68**	-0.37**	-0.11	-0.43**	-0.3**	-0.33**	-0.62**	0.32**	-0.4**	0.69**	-0.7**	-0.11	-0.4**	0.58**	-0.15	1				
PropQuaternary	0.11	0.53**	0.1	-0.15	-0.18	0.07	-0.03	-0.67**	-0.25*	0.27*	0.28*	-0.22	0.15	-0.24*	0.8**	0.13	0.36**	1			
MedHHIadj	0.17	-0.2	0.24*	0.51**	0.57**	0.44**	0.13	0.29*	-0.42**	0.57**	-0.56**	0.42**	0.44**	0.59**	-0.1	-0.31**	-0.43**	0.02	1		
vacanthousing	-0.19	-0.13	-0.07	-0.11	-0.02	-0.44**	-0.41**	0.208	0.91**	-0.22	0.21	-0.22	-0.41**	-0.06	-0.32**	-0.41**	0.24*	-0.28*	-0.39**	1	
MedHouseValueadj	0.141	-0.22	0.144	0.36**	0.59**	.34**	0.061	0.3**	-0.31**	0.85**	-0.47**	.27*	0.174	0.54**	-0.1	-0.41**	-0.35**	0.2	0.7**	-0.3*	1

Table 5.2.3

Pearson Correlations for Non-EPSCoR States

	ARandD adj	AAO adj	ADVS andE	AVGUG adj	BWF	Sand EHED	Sand EGRAD	Time Dummy	Totpop inM	PropFB	Proppop LessHSD	Proppop SomeCorA	Proppop Bachlor	Proppop GradProf	Propemply 16above	Prop. Prim	Prop. Sec.	Prop Quat	Med HHIadj	Vac HH	MedHH Valadj
ARandD adj	1																				
AAO adj	0.06	1																			
ADVSandE	0.12	-0.04	1																		
AVGUGadj	-0.08	-.46**	.4**	1																	
BWF	0.03	-.42**	.6**	.7**	1																
SandEHED	.25*	-0.05	.3**	.2*	.6**)	1															
SandEGRAD	0.18	-0.01	.7**	.4**	.6**	.5**	1														
Time Dummy	-0.19	-.91**	0.03	.5**	.4**	-0.02	0.1	1													
TotpopinM	-.27*	-0.09	0.05	0.2	-0.1	-0.05	-.3*	0.1	1												
PropFB	-.23*	-.36**	.3**	.4**	.6**	.3*	0.1	.4**	.6**	1											
Proppop LessHSD	0.03	.77**	-0.1	-0.4 **	-0.7 **	-0.3 **	-0.2	-0.8 **	0	-0.5 **	1										
Proppop SomeCorA	-0.09	-0.5 **	-0.4 **	-0.08	-0.1	-0.2	-0.4 **	0.5 **	0.1	0.1	-0.7 **	1									
Proppop Bachlor	0.12	0.1	.5**)	0.05	.6**	.6**	.5**	-0.2	-0.2	.3*	-0.2	-.3*	1								
Proppop GradProf	0.09	-0.46 **	0.7 **	.7**	.9**	.5**	.7**	.5**	-0.1	.5**	-.6**	-0.2	.5**	1							
Propemply 16above	.32**	.75**	-0.1	-.44**	-0.3 **	0.1	0	-0.8 **	-0.2	-0.4 **	0.6 **	-0.4 **	-0.1	-0.4 **	1						
PropPrimary	0.15	.40**	-.5**	-.7**	-.6**	-0.2	-.3**	-.5**	-0.1	-.4**	.3**	0.2	-.3*	-.63**	.53**	1					
PropSecondary	0.09	.66**	-.4**	-.5**	-.7**	-.3**	-.4**	-.7**	-0.1	-.6**	.7**	-0.2	-.4**	-.72**	.74**	.6**	1				
PropQuaternary	.23*	.57**	.4**	-0.2	0.2	.3**	.4**	-.7**	-0.1	0.1	.3*	-.5**	.3*	0.12	.77**	0.1	.3*	1			
MedHHIadj	-0.07	-0.4 **	0.2	.6**	.6**	.4**	0.03	0.4 **	0.1	0.5 **	-0.5 **	0.1	0.5 **	0.51 **	-0.53 **	-0.6 **	-0.6 **	-0.3 *	1		
Vacant housing	-0.33 **	-0.16	-0.01	0	-0.2	-.29*	-.3*	0.1	0.8 **	0.5 **	0.1	0.1	-.3**	-0.16	-0.2	-0.1	-0.1	-0.1	-0.2	1	
MedHouse Valueadj	0.02	-.45**	.4**	.6**	.8**	.5**	.3**	.5**	.3*	.7**	-.7**	0.1	.4**	.74**	-.33**	-.5**	-.5**	0.1	.6**	0.1	1

An examination of other SandT indicators, such as ADVSandE (*Advanced SandE degrees as share of SandE degrees conferred, by state*), SandEHED (*SandE degrees as share of higher education degrees conferred, by state*), SandEGRAD (*SandE graduate students per 1,000 individuals 25–34 years old, by state*) and their correlation with ARandDadj at the level of all states also demonstrates an overall very low positive association. Since these indicators represent higher education broadly, they indicate that a change in any of these indicators would result in a change in ARandDadj. When correlations between ARandDadj, on the one hand, and ADVSandE (.25*) at a significance of 0.05 and SandEHED (0.17), on the other, were examined at the level of EPSCoR states (Table 5.2.2) it was found that the correlations were once again very low positive. It was only with respect to the correlation between ARandDadj and SandEGRAD (0.49**) at the level of EPSCoR states (Table 5.2.2) that correlation was found to be moderate positive at a significance of 0.01 level. An examination of the Pearson correlation (Table 5.2.3) for these SandT indicators at the non-EPSCoR states reveals very low positive association between ARandDadj, on the one hand, and ADVSandE (0.12) and SandEGRAD (0.18), on the other. However, association between ARandDadj and SandEHED (.25*) was found very low positive at a significance of 0.05 level.

Among the other variables which hold significance is TimeDummy. Its correlation with ARandDadj for all states is -0.09 which indicates a value very close to zero, thus, meaning that there is very low association or there is no correlation. In other words, as time progresses ARandDadj reduces. This correlation, when examined in the case of EPSCoR states (Table 5.2.2), is 0.01 indicating similar very low association. Even in the case of non-EPSCoR states an examination of the Pearson correlation (Table 5.2.3) revealed -0.19 which is a case of very low negative correlation.

Other higher education variables also display low correlation with ARandDadj. ProppopBachlor or Proportion of Population with Bachelor's degree (.22**) and ProppopGradProf or Proportion of Population with graduate/ professional degree (.23**) both have very low positive correlation with ARandDadj. At the level of EPSCoR states (Table 5.2.2) the association between ProppopBachlor and ARandDadj is .23* which is also a low positive correlation with a significance level of 0.05, while the same association at the level of non-EPSCoR states (Table 5.2.3) shows a correlation of 0.12 which again indicates very low positive correlation. On the other hand, the correlation between ProppopGradProf and ARandDadj at the level of EPSCoR states (Table 5.2.2) turned out to be 0.35** which indicates a low positive association though at a significance level of 0.01, while at the non-EPSCoR state level [Table 5.2.3] the correlation between ProppopGradProf and ARandDadj is 0.09 which again indicates very low positive correlation.

Even the employment variable Propemply16above or Proportion of Employed Population 16 years and above at .26** has a very low positive correlation with ARandDadj. This correlation is very low positive at .18 for EPSCoR states (Table 5.2.2), but a low positive at .32** with a significance of 0.01 level for non-EPSCoR states (Table 5.2.3).

Similarly, the variable PropQuaternary or Proportion of Employed Population 16 years and above in Quaternary Sector at .22** too displays very low positive correlation with ARandDadj. This association at the level of EPSCoR and non-EPSCoR states, too, is very low positive.

Other SandT indicators and demographic variables for all states are also examined for their correlations. The indicator AAOadj which represents state's academic institutions publications output has high negative correlation at (-.84**) with the variable TimeDummy, indicating as time progresses the proportion of publication output to $ 1 million of academic RandD decreases. At the level of EPSCoR states (Table 5.2.2), too, the correlation between them turns out to be -.80** which indicates a high negative correlation, while at the level of non-EPSCoR states this correlation is -.91** with a significance of 0.01. Thus, there is a very high negative correlation at the level of non-EPSCoR states (Table 5.2.3).

The correlation between AAOadj and PropQuaternary is 0.57** with a significance of 0.01 at the level of states. For the same the correlation is 0.53** at the level of EPSCoR states (Table 5.2.2) with a significance of 0.01 level, while at the level of non-EPSCoR level (Table 5.2.3) the correlation is .57** which indicates a moderate positive correlation with a significance of 0.01 level.

Interestingly, there is moderate positive correlation between AAOadj and variables such as popLessHSD (.68**), i.e. Proportion of Population with High School Diploma or lesser, Propemply16above (.71**) and PropSecondary (.67**), i.e. Proportion of Employed Population 16 years and above in Secondary Sector which indicates moderate positive correlation. Correlations at the level of EPSCoR states (Table 5.2.2) too were moderate positive while at the level of non-EPSCoR states (Table 5.2.3) this correlation turns out to be high positive.

When relationship between PropFB or Proportion of Foreign Born and AAOadj was examined, the correlation is 0.21 which shows a very low positive association. Similar correlation at the level of EPSCoR states (Table 5.2.2) shows -.25* indicating very low negative correlation, while at the level of non-EPSCoR states (Table 5.2.3) the correlation is -.36** with a significance level of 0.01 which indicates low negative correlation.

An examination of correlation of other SandT indicators such as ADVSandE (-0.12), SandEHED (0.01) and SandEGRAD (0.01) with AAOadj demonstrates a markedly low and negligible association indicating that there is no correlation or weak association between other higher education indicators and publication output. However, when the same correlations are examined at the level of EPSCoR states (Table 5.2.2) it is found that the association between ADVSandE and AAOadj is -.32** at a significance level of 0.01 which indicates low negative correlation, while at the level of non-EPSCoR states (Table 5.2.3) the same association displays a correlation value of -0.04 which indicates a markedly low negative correlation. In the case of SandEHED and its correlation with AAOadj at the level of EPSCoR states (Table 5.2.2) the correlation is -0.03 and at the level of non-EPSCoR states (Table 5.2.3) the same association displays a correlation value of -0.05 which indicates a markedly low negative correlation. SandEGRAD and its correlation with AAOadj at the level of EPSCoR states (Table 5.2.2) is -0.15, thus, indicating a low negative correlation.

Even the relationship between academic publication output and MedHouseValueadj (-.27**) i.e. median housing value adjusted displays as having very low negative correlation. This relationship in the case of EPSCoR states (Table 5.2.2) has a correlation of -0.22 which is again very low negative association. However, the same in the case of non-EPSCoR states (Table 5.2.3) turns out to be -.45** with a significance level 0.01 which indicates low negative correlation.

In an examination of correlation of higher education indicators such as ADVSandE (.38**), SandEHED (.29**) and SandEGRAD (.19**) with PropFB, it is found that the association is low to very low in nature. When associations between PropFB and ADVSandE were examined at the level of EPSCoR states (Table 5.2.2) it is found that the correlation is .29* which again indicates that the association is very low positive. In the case of non-EPSCoR states (Table 5.2.3) this correlation is .33** which is low positive. In the case of SandEHED and PropFB at the level of EPSCoR states (Table 5.2.2) the correlation is 0.11 which indicates a very low association while in the case of non-EPSCoR states (Table 5.2.3) the same correlation value is 0.26*, i.e. once again a very low positive value at a significance of 0.05 level. The relationship between SandEGRAD and PropFB at 0.09 at the level of EPSCoR states (Table 5.2.2) shows markedly low positive association while at the level of non-EPSCoR states (Table 5.2.3) the correlation is 0.13, i.e. once again a very low positive value.

However, the correlation between ProppopBachlor and ADVSandE is .30 which displays a low positive correlation. The same in the case of EPSCoR states (Table 5.2.2) has a correlation value of -0.01 and in the case of non-EPSCoR states (Table 5.2.3) is 0.45** which indicates markedly low negative correlation in the case of EPSCoR states (Table 5.2.2) and low positive correlation in the case of non-EPSCoR states (Table 5.2.3) with a significance of 0.01.

On the other hand, ProppopGradProf when correlated with ADVSandE demonstrated an r value of .55** which shows moderate positive correlation. The same in the case of EPSCoR states (Table 5.2.2) shows a value of 0.2 which is very low positive association, while in the case of non-EPSCoR (Table 5.2.3) states has a correlation of 0.69**, i.e. it indicates high positive correlation with a significance level of 0.01.

When examining the association of ADVSandE and household variables, such as MedHHIadj and MedHouseValueadj it is found that the correlation between these variables and ADVSandE are low positive indicating that their association with ADVSandE is negligible. Even in the case of EPSCoR (Table 5.2.2) and non-EPSCoR states their correlation is very low positive. Though the relationship between ADVSandE and MedHHIadj at the level of EPSCoR states (Table 5.2.2) displays a significance of 0.05 which is noteworthy while in the case of the relationship between ADVSandE and MedHouseValueadj at the level of non-EPSCoR states (Table 5.2.3) the correlation value .36** demonstrates a significance of 0.01.

Similarly, at the level of all states, SandEHED and SandEGRAD indicators relationship with household variables MedHHIadj and MedHouseValueadj demonstrates a low positive association. Correlation between SandEHED and MedHHIadj at the level of EPSCoR states (Table 5.2.2) shows a value of 0.44** with a significance level of 0.01. It indicates low positive association while at the level of non-EPSCoR states (Table 5.2.3) displays a correlation of 0.39** with a significance level of 0.01 which once again indicates low positive association. In the case of correlation between SandEHED and MedHouseValueadj, it is found that the value is 0.34** at the level of EPSCoR states (Table 5.2.2) and 0.50** at the level of non-EPSCoR states (Table 5.2.3) which indicates significance level of 0.01. Thus, the association is low positive in both the cases. On the other hand, the correlation between SandEGRAD and MedHHIadj at the level of EPSCoR states (Table 5.2.2) shows a value of 0.13 while at the level of non-EPSCoR states [Table 5.2.3] is 0.03, thus, indicating a very low to markedly low positive association. The correlation between SandEGRAD and MedHouseValueadj at the level of EPSCoR states (Table 5.2.2) has a value of 0.061 and at the level of non-EPSCoR states (Table 5.2.3) is 0.32**, thus, indicating an association markedly low to very low positive.

In examining the correlation of the variable PropFB at the level of all states with ProppopGradProf it is found that ProppopGradProf with 'r' value of .55** has a moderate positive correlation with PropFB. At the level of EPSCoR states, the same correlation has a value of .45** while at the level of non-EPSCoR states the value is .50**. It thus indicates association of low positive to moderate positive with a significance level of 0.01 throughout.

When associations between household variables such as MedHHIadj and PropFB are examined it is found that the 'r' value of MedHHIadj at the level of all states is .57** which again indicates a moderate positive association. However, at the level of EPSCoR states it is the same but at the level of non-EPSCoR states it reduces to .47** indicating a decrease in association to a low positive. In the same vein, an examination of the correlation between MedHouseValueadj and PropFB shows that MedHouseValueadj carried an 'r' value of .78** which indicates a very high positive correlation. This correlation value increased to .85** at the level of EPSCoR states, but, at the level of non-EPSCoR states it reduces to .73** and yet the association is high positive with a significance of 0.01.

5.2.1.1 Comparing all the three Correlations

In the Table below (5.2.4), it would be apparent to find the variables different in their degrees of relationships with the dependent variable of Academic R and D in the case of All States, EPSCoR states and Non-EPSCoR states. There is switch and swift in the variables in case of both the states. An overview of the correlation values for ADVSandE (r = 0.25), BWF (r = 0.34), SandEGRAD (r = 0.49), ProppopLessHSD (r = -0.26), and ProppopGradProf (r = 0.35) indicates that the degree of positive or negative relationship between these variables with the dependent variable has grown much stronger for EPSCoR states as compared to the overall All-states sample. The same variables, however, in the case of Non-EPSCoR states do not have any significant correlations with the dependent variables. This is indicative of the fact that these variables strongly relate with the Academic R and D productivity in case of EPSCoR states, whereas they aren't as effective in case of Non-EPSCoR states. Further, while the r values for Time dummy is not significant in either of the three models, its degree is the strongest in case of Non-EPSCoR states as against EPSCoR. Overall, all states also suggest some other aspects of future policy interventions. These might be indicative of the fact that probably a focused intervention in terms of increasing the ADVSandE, BWF, SandEGRAD, and ProppopGradProf in a positive direction, and by reducing the levels of ProppopLessHSD (which is opposite of the Proportion of Graduates) might be very strongly instrumental in increasing the Academic R and D output in case of EPSCoR states as against the Non-EPSCoR states. This also suggests that spatial uneven development across the states of USA, as indicated by the EPSCoR states can stand at par with the Non-EPSCoR states with appropriate policy initiatives that will likely show positive results. This is illustrated in next sections that develop and discuss a solution with the use of regression model for policy interventions, by suggesting a statistical model to explain the patterns exhibited by the NSF and Census-based data.

Table 5.2.4

Comparing the Three Models of Correlations

Variables	ARandDadj (All States)	ARandDadj (EPSCoR States)	ARandDadj (Non-EPSCoR States)
ARandDadj	1	1	1
AAOadj	-0.012	-0.16	0.06
ADVSandE	.23**	.25*	0.12
AVGUGadj	0.11	0.18	-0.08
BWF	.20*	.34**	0.03
SandEHED	.26**	0.17	.25*
SandEGRAD	.24**	.49**	0.18
TimeDummy	-0.09	0.01	-0.19
totpopinM	-0.06	-0.21	-.27*
PropFB	-0.014	0.06	-.23*
ProppopLessHSD	-0.15	-.26*	0.03
ProppopSomeCorA	0.01	0.14	-0.09
ProppopBachlor	.22**	.23*	0.12
ProppopGradProf	.23**	.35**	0.09
Propemply16above	.26**	0.18	.32**
PropPrimary	-0.01	0.08	0.15
PropSecondary	0.02	-0.09	0.09
PropQuaternary	.22**	0.11	.23*
MedHHIadj	0.14	0.17	-0.07
vacanthousing	-0.11	-0.19	-.33**
MedHouseValueadj	0.12	0.141	0.02

5.3 Correlations for Land Grant Institutions

The results of correlation analysis using Pearson's R between the selected SandT indicators and socio-economic and demographic data for Land Grant Institutions (LGIs) are shown in Tables 5.3.1, 5.3.2 and 5.3.3. Overall, we witness a low but positive correlation between RandDExpatUCadj -- Research and Development Expenditures at Universities and Colleges (Adjusted) and other SANDT indicators and socio-economic and demographic data. In particular, the correlation between RandDExpatUCadj and TimeDummy at the level of all LGIs displays a value 0.10 indicating very low positive correlation while the same at the level of LGIs in EPSCoR states has a value .274* with a significance level 0.05 and at the level of LGIs for non-EPSCoR states the value is 0.12. It indicates very low positive correlation.

An examination of correlation between RandDExpatUCadj and PropFB displays a correlation value of 0.54** at the level of all LGIs with a significance level of 0.01, while the same at the level of LGIs in EPSCoR states display 0.03 which is markedly low positive and at the level of LGIs for non-EPSCoR states the value is 0.57**. It indicates moderate positive correlation.

Correlation between RandDExpatUCadj and ProppopGradProf shows a value of 0.22** at the level of all LGIs with a significance level of 0.01, while at the level of LGIs in EPSCoR states the same correlation carries a value of 0.18 and at the level of LGIs for non-EPSCoR states the value is 0.13. Similarly, an examination of the correlation between RandDExpatUCadj and PropQuaternary at the level of all LGIs displays a value of 0.06, while at the level of LGIs in EPSCoR states has a value of -0.16 and at the level of LGIs for non-EPSCoR states has a value of 0. Thus, it indicates that the association is very low negative correlation and since the value of correlation is zero at the level of LGIs for non-EPSCoR states, there is no correlation.

Other variables such as MedHHIadj when examined for their correlation with RandDExpatUCadj at the level of all LGIs display a value of 0.22** which clearly indicate a very low positive association. When the same was examined at the level of LGIs in EPSCoR states the correlation value is found to be 0.04, which was markedly low while it was 0.16 at the level of LGIs for non-EPSCoR states. A related household variable MedHouseValueadj when examined for its correlation with RandDExpatUCadj at the level of all LGIs demonstrate a correlation value of 0.45** at a significance level of 0.01. It indicates low positive correlation. Such a correlation value at the level of LGIs in EPSCoR states is 0.07 indicating a markedly low positive association, while at the level of LGIs for non-EPSCoR states the correlation value is 0.55** at a significance level of 0.01. Thus, it indicates moderate positive association.

FFRandDExpatUCadj or Federally Financed Research and Development Expenditures at University and Colleges (Adjusted), a yet another significant SandT indicator, show interesting correlations with PropFB and MedHouseValueadj, in particular. Correlations between FFRandDExpatUCadj and PropFB at the level of all LGIs display a value of 0.56** with a significance level of 0.01, indicating moderate positive correlation. However, the same correlation when examined at the level of LGIs in EPSCoR states show a value of 0.27* indicating very low positive association and 0.58** at the level of LGIs for non-EPSCoR states indicating moderate positive association.

An examination of correlation between FFRandDExpatUCadj and MedHouseValueadj at the level of all LGIs and at the level of LGIs for non-EPSCoR states displays values such as 0.49** and 0.59** at a significance level of 0.01, thus, displaying moderate positive association. However, when this correlation was examined at the level of LGIs in EPSCoR states the value was displayed to be 0.18 which indicates very low positive association.

In an examination of the correlation between TimeDummy and other variables, in particular, the correlation with PropQuaternary at the level of all LGIs is found to be -0.64** at a significance level of 0.01 which indicates moderate negative association. Interestingly, this correlation value remained nearly the same both in the case of LGIs in EPSCoR states (-0.65**) and at the level of LGIs for non-EPSCoR states (-0.66**). TimeDummy and ProppopGradProf, too, have nearly the same correlation across different scales, such as all LGIs in states (0.49**), LGIs in EPSCoR states (0.65**) and at the level of LGIs for non-EPSCoR states (0.49**). The resulting association is low positive to moderate positive with a significance level of 0.01.

Among other variables, the correlation of PropFB with MedHouseValueadj is high positive throughout at the level of all LGIs in states (0.78**), LGIs in EPSCoR states (0.84**) and LGIs in non-EPSCoR states (0.72**) though in each case the level of significance is 0.01. Similarly, the correlation between PropFB and MedHHIadj at the level of both all LGIs (0.57**) and LGIs in EPSCoR states (0.55**) is moderate positive, while at the level of LGIs in non-EPSCoR states (0.47**). Once again the level of significance in each case is 0.01.

Table 5.3.1

Pearson Correlations for All Land Grant Institutions

Variables	RandDExpatUCadj	FFRandDExpatUCadj	TimeDummy	totpopinM	Pr.FB	Pr.LessHSD	Pr.popSomeCorA	Pr.popBachlor	Pr.popGradProf	Pr.emply16above	Pr.Prim	Pr.Secd	Pr.Tert.	Pr.Quat	Pr.Quin	MedHHIadj	percapINadj	Pr.Vac.HH	MedHHValueadj
RandD ExpatUCadj	1																		
FFRandD ExpatUCadj	0.977**	1																	
TimeDummy	0.104	0.135	1																
totpopinM	0.787**	0.759**	0.05	1															
Pr.FB	0.543**	0.567**	0.305**	0.592**	1														
Pr.Less HSD	-0.183*	-0.223**	-0.756**	-0.05	-0.498**	1													
Pr.pop SomeCorA	0.076	0.086	0.547**	-0.04	0.168*	-0.74**	1												
Pr.pop Bachlor	0.099	0.085	-0.236**	0.048	0.294**	-0.158*	-0.199*	1											
Pr.pop GradProf	0.22**	0.264**	0.498**	0.097	0.549**	-0.648**	0.011	0.454**	1										
Pr.emply 16above	-0.078	-0.095	-0.789**	-0.1	-0.25**	0.43**	-0.321**	0.06	-0.288**	1									
Pr.Prim.	-0.187*	-0.218**	-0.297**	-0.326**	-0.482**	0.208**	0.192*	-0.212**	-0.505**	0.313**	1								
Pr.Secd.	-0.042	-0.058	-0.642**	0.049	-0.42**	0.679**	-0.469**	-0.224**	-0.523**	0.659**	0.02	1							
Pr.Tert.	-0.091	-0.096	-0.854**	-0.06	-0.279**	0.596**	-0.408**	-0.053	-0.424**	0.931**	0.368**	0.674**	1						
Pr.Quat.	0.065	0.075	-0.645**	0.07	0.223**	0.22**	-0.339**	0.274**	0.086	0.773**	-0.01	0.301**	0.737**	1					
Pr.Quin.	-0.121	-0.079	0.014	-0.2*	0.14	-0.189*	-0.071	0.281**	0.457**	-0.059	-0.05	-0.433**	-0.03	0.28**	1				
MedHHIadj	0.226**	0.209**	0.322**	0.18*	0.57**	-0.546**	0.205*	0.529**	0.565**	-0.241**	-0.485**	-0.423**	-0.449**	-0.01	0.06	1			
percapINadj	0.217**	0.205*	0.525**	0.171*	0.585**	-0.634**	0.15	0.497**	0.792**	-0.422**	-0.542**	-0.573**	-0.616**	-0.12	0.16	0.89**	1		
Pr.Vacant HH	-0.27**	-0.255**	0.045	-0.331**	-0.271**	-0.02	0.127	-0.195*	-0.114	0.044	0.243**	-0.07	0.09	-0.05	0.1	-0.264**	-0.244**	1	
MedHH Valueadj	0.453**	0.49**	0.387**	0.247**	0.782**	-0.59**	0.154	0.359**	0.683**	-0.196*	-0.46**	-0.414**	-0.308**	0.168*	0.211**	0.687**	0.685**	-0.181*	1

Table 5.3.2

Pearson Correlations for EPSCoR Land Grant Institutions

	RandDExpatUCadj	TimeDummy	FFRandDExpatUCadj	totpopinM	PropFB	ProppopLessHSD	ProppopSomeCorA	ProppopBachlor	ProppopGradProf	Propemply16above	PropPrimary	PropSecondary	PropTertiary	PropQuaternary	PropQuinary	MedHHIadj	percapitaINadj	Propvacanthousin	MedHouseValuead
RandDExpatUC	1																		
TimeDummy	0.274 *	1																	
FFRandDExpat	0.337 **	0.344 **	1																
totpopinM	0.446 **	0.07	0.29 *	1															
PropFB	0.034	0.293 **	0.278 *	-0.21	1														
ProppopLessHS	-0.099	-0.758 **	-0.24 *	0.333 **	-0.449 **	1													
ProppopSomeC	0.061	0.62 **	0.108	-0.3 **	0.338 **	-0.883 **	1												
ProppopBachlo	-0.241 *	-0.356 **	-0.296 **	-0.352 **	0.11	-0.03	-0.09	1											
ProppopGradPr	0.18	0.65 **	0.228 *	-0.21	0.441 **	-0.722 **	0.371 **	0.129	1										
Propemply16ab	-0.207	-0.746 **	-0.306 **	-0.285 *	-0.17	0.344 **	-0.282 *	0.135	-0.301 **	1									
PropPrimary	-0.182	-0.285 *	-0.286 *	-0.383 **	-0.423 **	0.06	0.21	-0.025	-0.433 **	0.332 **	1								
PropSecondary	-0.101	-0.626 **	-0.124	0.296 **	-0.399 **	0.69 **	-0.702 **	-0.109	-0.405 **	0.599 **	-0.147	1							
PropTertiary	-0.188	-0.844 **	-0.192	-0.13	-0.256 *	0.569 **	-0.466 **	0.028	-0.492 **	0.904 **	0.361 **	0.636 **	1						
PropQuaternary	-0.167	-0.659 **	-0.111	-0.241 *	0.282 *	0.28 *	-0.22	0.145	-0.23 *	0.797 **	0.101	0.371 **	0.76 **	1					
PropQuinary	-0.011	0.09	0.327 **	-0.14	0.249 *	-0.236 *	0.273 *	0.06	0.094	-0.227 *	0.062	-0.411 **	-0.055	0.013	1				
MedHHIad	0.046	0.284 *	-0.153	-0.401 **	0.558 **	-0.556 **	0.425 **	0.449 **	0.585 **	-0.09	-0.312 **	-0.428 **	-0.376 **	0.025	0.08	1			
percapitalNadj	0.114	0.538 **	-0.13	-0.275 *	0.476 **	-0.651 **	0.487 **	0.292 **	0.702 **	-0.31 **	-0.365 **	-0.527 **	-0.601 **	-0.228 *	-0.05	0.928 **	1		
Propvacanthous	-0.196	0.05	-0.035	-0.355 **	-0.119	-0.187	0.038	0.141	0.313 **	0.12	-0.017	-0.074	0.059	0.083	0.18	0.13	0.11	1	
MedHouseValu	0.075	0.305 **	0.185	-0.317 **	0.847 **	-0.473 **	0.278 *	0.174	0.533 **	-0.09	-0.405 **	-0.349 **	-0.224	0.209	0.23 *	0.697 **	0.585 **	0.09	1

Table 5.3.3

Pearson Correlations for Non-EPSCoR Land Grant Institutions

	RandDExpat UCadj	FFRandD ExpatUCadj	Time Dummy	Totpop inM	Prop FB	Proppop LessHS	ProppopSomeCorA	Proppop Bachlor	Proppop GradProf	Propempl 16above	Prop Prim.	Prop Secd	Prop Tert.	Prop Quat.	Prop Quin.	Med HHIadj	Percapita INadj	Pr. VacHH	MedHH. VallAdj
RandD ExpatUCadj	1																		
FFRandD ExpatUCadj	0.992**	1																	
TimeDummy	0.125	0.139	1																
totpopinM	0.773**	0.746**	0.076	1															
PropFB	0.574**	0.581**	0.37**	0.628**	1														
Proppop LessHSD	-0.178	-0.207	-0.792**	0.028	-0.498**	1													
Proppop SomeCorA	0.123	0.126	0.49**	0.041	0.129	-0.65**	1												
Proppop Bachlor	0.017	0.029	-0.152	-0.143	0.245*	-0.173	-0.287*	1											
Proppop GradProf	0.136	0.184	0.49**	-0.106	0.495**	-0.625**	-0.154	0.528**	1										
Propemply 16above	-0.13	-0.122	-0.84**	-0.183	-0.397**	0.572**	-0.366**	-0.05	-0.364**	1									
PropPrimary	-0.053	-0.071	-0.466**	-0.093	-0.439**	0.344**	0.186	-0.26*	-0.633**	0.531**	1								
Prop Secondary	-0.109	-0.125	-0.67**	-0.039	-0.569**	0.722**	-0.219	-0.392**	-0.723**	0.736**	0.545**	1							
Prop Tertiary	-0.104	-0.1	-.857**	-0.056	-0.322**	0.64**	-0.366**	-0.13	-0.438**	0.963**	0.532**	0.734**	1						
Prop Quaternary	0.007	0.024	-0.665**	-0.067	0.066	0.282*	-0.445**	0.26*	0.12	0.77**	0.114	0.236*	0.768**)	1					
Prop Quinary	-0.078	-0.083	-0.026	-0.23*	0.145	-0.194	-0.299**	0.457**	0.653**	0.047	-0.331**	-0.464**	-0.02	0.469**	1				
MedHHIadj	0.163	0.179	0.429**	0.039	0.472**	-0.477**	0.027	0.502**	0.506**	-0.527**	-0.628**	-0.56**	-0.601**	-0.268*	0.097	1			
Percapita INadj	0.129	0.149	0.597**	-0.017	0.529**	-0.587**	-0.086	0.544**	0.819**	-0.646**	-0.724**	-0.772**	-0.711**	-0.23*	0.34**	0.835**	1		
PropvacantHH	-0.178	-0.177	0.069	-0.067	-0.08	-0.049	0.219	-0.3**	-0.11	0.03	0.07	-0.01	0.11	0.06	0.01	-0.48**	-0.29**	1	
MedHH Valueadj	0.552**	0.59**	.483**	.237*	0.728**	-0.661**	0.087	0.403**	0.737**	-0.331**	-0.506**	-0.538**	-0.382**	0.048	0.245*	0.634**	0.709**	-0.25*	1

Table 5.3.4

Comparison of Three Categories of LGIs Pearson Correlations

Categories	All States	EPSCoR	Non-EPSCoR
Variables	RandD ExpatUCadj	RandD ExpatUCadj	RandD ExpatUCadj
FFRandDExpatUCadj	.977**	.337**	.992**
TimeDummy	0.104	.274*	0.125
totpopinM	.787**	.446**	.773**
Pr.FB	.543**	0.034	.574**
Pr.LessHSD	-.183*	-0.099	-0.178
Pr.popSomeCorA	0.076	0.061	0.123
Pr.popBachlor	0.099	-.241*	0.017
Pr.popGradProf	.220**	0.180	0.136
Pr.emply16above	-0.078	-0.207	-0.13
Pr.Prim.	-.187*	-0.182	-0.053
Pr.Secd.	-0.042	-0.101	-0.109
Pr.Tert.	-0.091	-0.188	-0.104
Pr.Quat.	0.065	-0.167	0.007
Pr.Quin.	-0.121	-0.011	-0.078
MedHHIadj	.226**	0.046	0.163
percapINadj	.217**	0.114	0.129
Pr.VacantHH	-.270**	-0.196	-0.178
MedHHValueadj	.453**	0.075	.552**

Table 5.3.4 demonstrates the zero order correlation coefficients for All Land Grant Institutions in all states, in EPSCoR states, and in Non-EPSCoR states to highlight relationship of various variables in all the three models, and how might they vary depending upon the characteristics of the states they represent. As can be said from the above, in the case of all states, there are many variables with strong positive or negative relationship with the dependent variable RandDExpatUCadj, and significant at 0.01 and

0.05 levels, for example, FFRandDExpatUCadj with r = 0.977**, totpopinM with r = 0.787**, PropofFB with r = 0.543, etc.

In the case of EPSCoR and Non-EPSCoR states, though, it is interesting to see that the variables that show significant positive or negative relationships with the dependent variables have changed a little bit, with the degrees of relationship also different. For example, while Non-EPSCoR states have the variables MedHHValueadj (r = 0.552**), totpopinM (r = 0.773**), Prop.of FB (r = 0.574**), and FFRandDExpatUCadj (r = 0.992 **) demonstrating strong relationship with the dependent variables in the case of EPSCoR states, most of these variables don't have significant relationship, even though three common variables of FFRandDExpatUCadj, TimeDummy, totpopinM have significant relationship, their strength is weak. This speaks of certain characteristics of EPSCoR states that make them distinct from the Non-EPSCoR states.

Interestingly, in the case of EPSCoR states, the correlation for proportion of Bachelors is -0.241, indicating the decline in RandDExpatUCadj with increase in the share of Bachelor educated population. This might be indicative that in the lagging states, which is synonymous with EPSCoR states in this study, the educated population with Bachelors degree are likely not contribute towards research and development activities. Another interesting and expected result is the sign on the variable proportion of those employed (16 years and above) in the case of Non-EPSCoR states, which has a much stronger negative r = -0.201 as against a weaker r = -0.13 in case of the EPSCoR states. This variable, thought not significant, again fleshes out that the levels of unemployment are relatively much higher in the EPSCoR states compared to Non-EPSCOR states.

5.4 Regression Analysis

In this study linear regression was applied to the statistically significant variables found in the Pearson's correlation analysis. Besides, the variables described above, one more variable has been created, namely, a pooling metric or time dummy (T). The creation of a dummy variable in a pooled time-series study like this helps control for variance within and between the annual data sets (Gatrell 2002; Gatrell and Ceh 2003). The pooling term is defined below as:

T = a pooling metric based on year (1993-94 = 1, 1998-99 = 2 and 2004-05 = 3)

Due to limited time-series data for some of the variables, the data in the time periods referred to above were averaged. Using the data described above six equations were derived. Thus, the regression models presented below were tested using both ordinary least squares (OLS) regression and the stepwise backward approach. The intent of the creation of each of these regression models has been to investigate and demonstrate the causal relationship between research and development as share of gross state product (as a proxy of SandT) and other indicators considered in this study and their capacity to explain economic development in places.

Using the data described above, six equations were derived. The regression models presented below were tested using ordinary least squares (OLS) regression and the stepwise approach. As there is no a priori basis for predicting the exact form of the regression, a linear model was employed. It produced highly significant results and gave no indication that a transformation would improve results. The intent of these regression models is to demonstrate the significance of academic research and development as an explanatory indicator of science and technology-based local and regional economic development. This modeling exercise also aims at establishing discussion and debate on the general issue of SandT indicators. Each of these six regression models has been created to investigate the relationship between academic RandD, other SandT indicators, such as those pertaining to higher education, workforce, research and development outputs and socio-economic and demographic data. The models also explore how these indicators and variables may or may not perform differently in states and land grant institutions.

5.4.1 Model I: Explaining Patterns in All States

The first model examines whether independent variables, such as MedHouseValueadj, PropQuaternary, totpopinM, Propvacanthousing, ADVSandE, ProppopBachlor, SandEHED, MedHHIadj, AAOadj, SandEGRAD, PropFB, BWF, Propemply16above, ProppopGradProf, TimeDummy can statistically explain variance in the dependent variable, academic RandD at the country level. This model has been created to explore the implication of academic research performed in a state relative to the size of the state's economy. Using Ordinary Least Squares (OLS) regression, this model tests the relationship between academic RandD (Y – all states) and other SANDT indicators and socio-economic and demographic conditions:

Y (All States) = 5.351 - 0.325* (AAOadj) - 0.037* (ADVSandE) + 0.00* (AVGUGadj) + 0.201* (SandEGRAD) - 1.306* (TimeDummy) + 13.467* (ProppopGradProf) + 1.479* (Propemply16above) .... (1)

Where Y = dependent variable

5.351 is constant

AAOadj is academic RandD at the country level or all states

ADVSandE is academic article output per $ 1 million of academic RandD by state

SandEGRAD is SandE degrees as share of SandE degrees conferred

AVGUGadj is average undergraduate charge at public 4-year institutions

SandEGRAD is SandE graduate students per 1,000 individuals (25–34 years old).

Time Dummy is a pooling metric created in a pooled-time series study like this for it serves to control for variance within and between the annual data sets where

ProppopGradProf is proportion of population with graduate/ professional degree

Propemply16above is proportion of employed population 16 years and above.

In conducting this modeling exercise, stepwise backward regression was done. The system generated 11 iterations of models by automatically dropping off the variables that were deemed insignificant according to the probability values of 0.05 for entry, and 0.10 for removal. A default CI value of 85% was maintained. Out of the 11 iterations of regression models generated, all of them were tested for suitability and appropriateness in explaining the spatial patterns of dependent variable. 4 out of 11 iterations generated are presented below in Table 5.4.1.1. It is clear that the r-square values remain almost same across all the four models. Even in the 11th iteration, the r-square value remains 29.4, however, the 4 iterations have similar values ranging from 0.314 to 0.311, which is not much of a change. However, when looking at the consistency of signs on the B and Beta values across all the four, as well as the p-value of the 4 models, it is striking that there are many variables with inconsistent signs on their B and Beta coefficients, as well as many of them seem insignificant, even when a 90% confidence interval is considered. By implication one could test the suitability for a model generated from OLS regressions.

Table 5.4.1.1

Stepwise Backward Regression for All States

	Step Backward Model I					**Step Backward Model II**				
Variables	Und. Coff.		St. Cof.			Und. Cof.		St. Cof.		
	B	Std. Err	Beta	t	Sig.	B	Std.Err	Beta	t	Sig.
(Constant)	-4.84	4.396		-1.101	0.273	-3.845	3.83		-1.004	0.317
AAOadj	-0.228	0.069	-0.496	-3.313	0.001	-0.229	0.069	-0.499	-3.348	0.001
ADVSandE	0.09	0.05	0.399	1.806	0.073	0.078	0.043	0.347	1.829	0.07
AVGUGadj	0	0	0.658	1.594	0.113	0	0	0.548	1.625	0.106
BWF	0.041	0.042	0.22	0.974	0.332	0.034	0.039	0.184	0.87	0.386
SandEHED	-0.016	0.035	-0.057	-0.466	0.642	0.037	0.025	0.281	1.508	0.134
SandEGRAD	0.045	0.03	0.338	1.512	0.133	x	x	x	x	x
TimeDummy	0.843	0.918	0.527	0.918	0.36	0.623	0.785	0.389	0.794	0.429
ProppopBachlor	24.144	14.346	0.63	1.683	0.095	20.082	11.356	0.524	1.768	0.079
ProppopGradProf	-44.46	35.128	-1.136	-1.266	0.208	-34.99	28.555	-0.894	-1.225	0.223
Propemply16above	11.469	2.681	1.134	4.277	0	10.771	2.217	1.065	4.858	0
PropQuaternary	-5.175	3.083	-0.328	-1.679	0.096	-5.251	3.07	-0.333	-1.71	0.089
MedHHIadj	0	0	-0.339	-1.29	0.199	0	0	-0.285	-1.212	0.228
Propvacanthousing	-7.719	3.388	-0.191	-2.279	0.024	-7.714	3.378	-0.191	-2.283	0.024
MedHouseValueadj	0	0	0.119	0.698	0.487	0	0	0.083	0.548	0.585
R Square					0.316					0.315
Variables	Und. Coff.		St. Cof.			Und. Cof.		St.Cof.		
	B	Std. Err	Beta	t	Sig.	B	Std. Err	Beta	t	Sig.
(Constant)	-3.118	3.584		-0.87	0.386	-0.946	1.227		-0.771	0.442
AAOadj	-0.234	0.068	-0.508	-3.444	0.001	-0.251	0.062	-0.547	-4.054	0
ADVSandE	0.066	0.037	0.294	1.806	0.073	0.05	0.026	0.221	1.896	0.06
AVGUGadj	0	0	0.454	1.568	0.119	0	0	0.307	1.724	0.087
BWF	0.033	0.039	0.18	0.854	0.395	0.03	0.039	0.161	0.772	0.441
SandEHED	0.032	0.022	0.239	1.411	0.161	0.024	0.019	0.182	1.261	0.209
SandEGRAD	x	x	x	x	X	x	x	x	x	x
TimeDummy	0.473	0.734	0.296	0.645	0.52	x	x	x	x	x
ProppopBachlor	17.345	10.17	0.453	1.705	0.09	11.452	4.462	0.299	2.567	0.011
ProppopGradProf	-27.06	24.551	-0.692	-1.102	0.272	-13.67	13.093	-0.349	-1.044	0.298
Propemply16above	10.286	2.027	1.017	5.074	0	9.506	1.623	0.94	5.857	0
PropQuaternary	-4.93	3.006	-0.312	-1.64	0.103	-5.983	2.518	-0.379	-2.376	0.019
MedHHIadj	0	0	-0.208	-1.108	0.27	0	0	-0.119	-0.933	0.352
Propvacanthousing	-7.582	3.361	-0.188	-2.256	0.026	-7.022	3.24	-0.174	-2.167	0.032
MedHouseValueadj	X	X	X	X	X	x	x	x	x	x
R Square	Step Backward Model III:0.313					Step Backward Model IV : 0.311				

Using a similar rationale an OLS regression model was conducted by first taking all the independent variables. The dependent variable being academic RandD (ARandD), and the explanatory variables consist of AAOadj, ADVSandE, AVGUGadj, BWF, SandEHD, SandEGRAD, TimeDummy, ProppopBachlor, Propemply16above, PropQuaternary, MedHHladj, Propvacanthousing, and MedHouseValueadj. As can be seen from the first regression model generated for all states presented in Table 5.4.1.2, four variables (SandEHED, TimeDummy, ProppopGradProf, and PropQuaternary) out of the total fourteen included in the OLS regression have inconsistent signs with those of their respective r-values generated in zero-order pearson correlations matrix. The r-square value is 0.316, and the only variables significant, at even 90% are AAOadj, ADVSandE, ProppopBachlor, Propemply16above, PropQuaternary, and MedHouseValueadj. As such the model suggests that there is some sort of multicollinearity among the independent variables selected in the model, and that the model needs to be run once again. Further diagnosis of the variables in the correlations Table 5.2.1 shows a high degree of correlation between sets of variables, such as PropQuaternary and ProppopBachlor (r = 0.274**), between PropQuaternary and SandEHD, r = 0.251**, and so on. It requires dropping some of these highly correlated variables and rerun another OLS regression. It is done repeatedly until a relatively satisfactory regression model is obtained that can be used to explain the data patterns as observed for all states. In the Table 5.4.1.2, there are other iterations of OLS regression models which are discussed as a relatively correct identified model for discussing the ARandD patterns for all states in this regression modeling.

Table 5.4.1.2

Ordinary Least Squares Regression Models for All States

	Und. Cof.		St. Cof.			Und. Cof.		St. Cof.		
	B	Std. Err	Beta	t	Sig.	B	Std. Err	Beta	t	Sig.
(Constant)	-4.840	4.396		-1.101	0.273	5.129	1.972		2.601	0.010
AAOadj	-0.228	0.069	-0.496	-3.313	0.001	-0.335	0.062	-0.73	-5.368	0.000
ADVSandE	0.090	0.050	0.399	1.806	0.073	-0.032	0.022	-0.12	-1.463	0.146
AVGUGadj	0.000	0.000	0.658	1.594	0.113	0.000	0.000	0.17	1.576	0.117
BWF	0.041	0.042	0.220	0.974	0.332	-0.023	0.032	-0.11	-0.733	0.465
SandEHED	-0.016	0.035	-0.057	-0.466	0.642	0.005	0.025	0.016	0.188	0.851
SandEGRAD	0.045	0.030	0.338	1.512	0.133	0.183	0.032	0.481	5.652	0.000
TimeDummy	0.843	0.918	0.527	0.918	0.360	-1.060	0.421	-0.67	-2.520	0.013
ProppopBachlor	24.144	14.346	0.630	1.683	0.095	5.317	6.146	0.129	0.865	0.388
ProppopGradProf	-44.459	35.128	-1.136	-1.266	0.208	15.371	9.716	0.318	1.582	0.116
Propemply16above	11.469	2.681	1.134	4.277	0.000	2.399	1.510	0.234	1.588	0.115
PropQuaternary	-5.175	3.083	-0.328	-1.679	0.096	x	x	x	x	x
MedHHIadj	0.000	0.000	-0.339	-1.290	0.199	0.000	0.000	-0.24	-1.624	0.107
Propvacanthousing	-7.719	3.388	-0.191	-2.279	0.024	-3.723	2.934	-0.09	-1.269	0.207
MedHouseValueadj	0.000	0.000	0.119	0.698	0.487	0.000	0.000	-0.01	-0.050	0.960
R-Square	Model: OLS I : 0.316					Model: OLS II : 0.461				

	Und. Cof.		St. Cof			Und. Cof.		St. Cof.		
	B	Std. Err	Beta	t	Sig.	B	Std. Err	Beta	t	Sig.
(Constant)	5.351	1.465		3.652	0.000	5.281	1.548		3.412	0.001
AAOadj	-0.325	0.059	-0.711	-5.545	0.000	-0.324	0.060	-0.71	-5.423	0.000
ADVSandE	-0.037	0.020	-0.139	-1.812	0.072	-0.036	0.020	-0.14	-1.767	0.079
AVGUGadj	0.000	0.000	0.140	1.391	0.166	0.000	0.000	0.138	1.371	0.172
BWF	x	x	x	x	x					
SandEHED	x	x	x	x	x	0.003	0.023	0.011	0.146	0.884
SandEGRAD	0.201	0.030	0.529	6.721	0.000	0.201	0.030	0.527	6.651	0.000
TimeDummy	-1.306	0.295	-0.827	-4.434	0.000	-1.298	0.301	-0.82	-4.309	0.000
ProppopBachlor	x	x	x	x	x	x	x	x	x	x
ProppopGradProf	13.467	6.844	0.279	1.968	0.051	13.327	6.935	0.28	1.922	0.057
Propemply16above	1.479	1.204	0.144	1.229	0.221	1.462	1.213	0.143	1.205	0.230
PropQuaternary	x	x	x	x	x	x	x	x	x	x
MedHHIadj	0.000	0.000	-0.146	-1.526	0.129	0.000	0.000	-0.15	-1.486	0.139
Propvacanthousing	x	x	x	x	x	x	x	x	x	x
MedHouseValueadj	x	x	x	x	x	x	x	x	x	x
R-Square	Model: OLS III- FINAL MODEL : 0.450					Model: OLS IV : 0.450				

Table 5.4.1.3

Final Regression Model for All States

Model: OLS III					
	Und. Cof.		St. Cof.		
	B	Std. Err	Beta	t	Sig.
(Constant)	5.351	1.465		3.652	0.000
AAOadj	-0.325	0.059	-0.711	-5.545	0.000
ADVSandE	-0.037	0.020	-0.139	-1.812	0.072
AVGUGadj	0.000	0.000	0.140	1.391	0.166
BWF	x	x	x	x	x
SandEHED	x	x	x	x	x
SandEGRAD	0.201	0.030	0.529	6.721	0.000
TimeDummy	-1.306	0.295	-0.827	-4.434	0.000
ProppopBachlor	x	x	x	x	x
ProppopGradProf	13.467	6.844	0.279	1.968	0.051
Propemply16above	1.479	1.204	0.144	1.229	0.221
PropQuaternary	x	x	x	x	x
MedHHIadj	0.000	0.000	-0.146	-1.526	0.129
Propvacanthousing	x	x	x	x	x
MedHouseValueadj	x	x	x	x	x
R-Square	0.450				

5.4.2 Model II: Explaining Patterns in EPSCoR States

Using a similar rationale two more regression models were developed to address the assertion that academic RandD can be a valuable basis for future economic development. This time the regression model uses academic RandD as a dependent variable at the level of EPSCoR states or lagging states. This model too uses the same set of independent variables as was used in model one, i.e. variables, such as MedHouseValueadj, PropQuaternary, totpopinM, Propvacanthousing, ADVSandE, ProppopBachlor, SandEHED, MedHHIadj, AAOadj, SandEGRAD, PropFB, BWF, Propemply16above, ProppopGradProf, TimeDummy. Once again this model uses ordinary least squares (OLS) regression to test the relationship between academic RandD (Y – EPSCoR states) and other SANDT indicators and socio-economic and demographic variables.

Y (EPSCoR States) = 4.579-0.316*(AAOadj) + 0.042*(BWF) + 0.159*(SandEHED) - 1.333*(TimeDummy) + 4.797*(ProppopBachlor) + 15.038*(ProppopGradProf) + 10.052*(Propemply16above) .... (2)

Where Y is the dependent variable

4.579 is constant

AAOadj is academic RandD at the level of EPSCoR states

BWF is Bachelor's degree holders as share of workforce for EPSCoR states

SandEHED is SandE degrees as share of higher education degrees conferred for EPSCoR states

TimeDummy is Time Dummy for EPSCoR states

ProppopBachlor is Proportion of Population with Bachelor's degree for EPSCoR states

ProppopGradProf is Proportion of Population with graduate/ professional degree for EPSCoR states

Propemply16above is Proportion of Employed Population 16 years and above for EPSCoR states

In conducting this modeling exercise SPSS generated three iterations by automatically dropping off the variable that was deemed insignificant depending upon probability values and confidence intervals. Out of the three iterations of regression models generated, all were tested for suitability and appropriateness in explaining the significance of the dependent variable. All the three iterations generated are presented below in Table 5.4.2. It is observed that the r-square values remain nearly the same in all the three iterations, i.e. 0.64, 0.61 and 0.56, respectively.

Table 5.4.2

Regression Model for EPSCoR States

	Model: OLS I					Model: OLS II					Model: OLS III – FINAL MODEL				
	Und. Cof.		St. Cof.			Und. Cof.		St. Cof.			Und. Cof.		St. Cof.		
	B	Std. Err	Beta	t	Sig.	B	Std. Err	Beta	t	Sig.	B	Std. Err	Beta	t	Sig.
(Constant)	3.858	2.365		1.631	0.108	3.330	2.344		1.420	0.161	4.579	1.827		2.506	0.015
AAOadj	-0.373	0.070	-0.881	-5.339	0.000	-0.367	0.069	-0.865	-5.313	0.000	-0.316	0.063	-0.745	-5.042	0.000
ADVSandE	0.015	0.031	0.066	0.492	0.624	-0.009	0.028	-0.041	-0.333	0.740	x	x	x	x	x
AVGUGadj	0.000	0.000	0.546	3.300	0.002	0.000	0.000	0.451	2.794	0.007	0.000	0.000	0.311	2.228	0.029
BWF	0.053	0.042	0.206	1.247	0.218	0.041	0.042	0.159	0.973	0.334	0.042	0.043	0.162	0.968	0.337
SandEHED	-0.051	0.038	-0.183	-1.344	0.184	-0.040	0.032	-0.145	-1.268	0.210	0.159	0.038	0.423	4.214	0.000
SandEGRAD	0.187	0.046	0.498	4.036	0.000	0.204	0.041	0.543	4.960	0.000	X	X	X	X	X
TimeDummy	-1.378	0.509	-0.913	-2.707	0.009	-1.263	0.486	-0.837	-2.598	0.012	-1.333	0.435	-0.883	-3.061	0.003
totpopinM	0.170	0.113	0.195	1.507	0.137	0.211	0.104	0.242	2.028	0.047	X	X	X	X	X
PropFB	-7.322	7.896	-0.255	-0.927	0.358	X	X	X	X	X	X	X	X	X	X
ProppopBachlor	10.99	7.483	0.267	1.469	0.147	10.87	7.238	0.264	1.502	0.138	4.797	6.480	0.117	0.740	0.462
ProppopGradProf	5.092	14.474	0.089	0.352	0.726	6.987	13.950	0.122	0.501	0.618	15.038	12.513	0.263	1.202	0.234
Propemply16above	2.539	2.456	0.254	1.034	0.305	1.517	1.750	0.152	0.867	0.389	0.052	1.637	0.005	0.032	0.975
PropQuaternary	-2.706	4.452	-0.164	-0.608	0.546	X	X	X	X	X	X	X	X	X	X
MedHHIadj	0.000	0.000	-0.523	-2.836	0.006	0.000	0.000	-0.470	-2.545	0.013	0.000	0.000	-0.495	-2.715	0.009
Propvacanthousing	-4.906	5.408	-0.131	-0.907	0.368	X	X	X	X	X	X	X	X	X	X
MedHouseValueadj	0.000	0.000	0.567	2.368	0.021	0.000	0.000	0.292	1.973	0.053	0.000	0.000	0.211	1.410	0.163
R Square	0.644					0.615					0.560				

Table 5.4.2.1

Final Regression Model for EPSCoR States

	Und. Cof.		Std. Cof.		
	B	Std. Err	Beta	t	Sig.
(Constant)	4.579	1.827		2.506	0.015
AAOadj	-0.316	0.063	-0.745	-5.042	0.000
ADVSandE	x	x	x	x	x
AVGUGadj	0.000	0.000	0.311	2.228	0.029
BWF	0.042	0.043	0.162	0.968	0.337
SandEHED	0.159	0.038	0.423	4.214	0.000
SandEGRAD	X	X	X	X	X
TimeDummy	-1.333	0.435	-0.883	-3.061	0.003
totpopinM	X	X	X	X	X
PropFB	X	X	X	X	X
ProppopBachlor	4.797	6.480	0.117	0.740	0.462
ProppopGradProf	15.038	12.513	0.263	1.202	0.234
Propemply16above	0.052	1.637	0.005	0.032	0.975
PropQuaternary	X	X	X	X	X
MedHHIadj	0.000	0.000	-0.495	-2.715	0.009
Propvacanthousing	X	X	X	X	X
MedHouseValueadj	0.000	0.000	0.211	1.410	0.163
R Square					0.560

In the first and second iterations of model two in Table 5.4.2 one finds far too many variables carry inconsistency of signs on the B and Beta which is a significant attribute of examination. In the first iteration of Table 5.4.2 it is found that 6 out of 17 variables carry inconsistent signs on their B and Beta coefficients as well as many of them seem insignificant even when 90% confidence interval is considered. However, when these iterations were diagnosed and variables cross verified with their corresponding correlation Table 5.2.2 for a best fit model, it was found that the third iteration in table 5.4.2 was most satisfactory. As such, the third iteration of Table 5.4.2

with a r-square 0.56 is considered as the best fit regression model at the level of EPSCoR states.

An observation across the three iterations was that variables, such as AAOadj, AVGUGadj, SandEHD, TimeDummy and MedHHladj held their importance consistently. The significance of academic article output, average undergraduate charge at public 4-year institutions, SandE degrees as share of higher education degrees conferred, time dummy and median household income is understandable. In particular, the emergence of academic article output as a significant variable in explaining academic RandD is especially notable, as it reflects growth in a very significant attribute of SandT indicator.

5.4.3 Model III: Explaining Non-EPSCOR States

The third regression model for non-EPSCoR states presented below also uses OLS regression to establish causal relationship between dependent variable academic RandD and other SandT indicators and socio-economic and demographic variables.

In this multiple regression model only four explanatory variables, namely, publication output, Advanced SandE degrees as share of SandE degrees conferred, Bachelor's degree holders as share of workforce, and Time Dummy emerged as having significant influence on academic research and development in the non-EPSCoR states. The significance of academic article output is already accounted for both in the case of all states and EPSCoR states. The next variable that contributes importantly to the explanation of academic RandD is advanced SandE degrees as share of SandE degrees conferred.

Table 5.4.3

Regression Model for Non-EPSCoR States

	Und. Cof.		St. Cof.			Und. Cof.		St. Cof.		
	B	Std. Err	Beta	t	Sig.	B	Std. Err	Beta	t	Sig.
(Constant)	16.34	4.14		3.95	0.00	9.82	2.34		4.20	0.00
AAOadj	-0.58	0.11	-1.18	-5.20	0.00	-0.52	0.11	-1.07	-4.87	0.00
ADVSandE	0.00	0.04	0.01	0.07	0.94	0.00	0.04	-0.01	-0.09	0.93
AVGUGadj	0.00	0.00	-0.15	-0.94	0.35	0.00	0.00	-0.10	-0.76	0.45
BWF	-0.04	0.05	-0.23	-0.95	0.35	-0.08	0.04	-0.38	-1.87	0.07
SandEHED	0.05	0.04	0.16	1.38	0.17	0.03	0.04	0.09	0.79	0.43
SandEGRAD	0.26	0.05	0.66	5.56	0.00	0.25	0.05	0.64	5.55	0.00
TimeDummy	-2.83	0.77	-1.78	-3.67	0.00	-1.90	0.39	-1.19	-4.93	0.00
totpopinM	-0.04	0.03	-0.20	-1.21	0.23	-0.01	0.03	-0.06	-0.36	0.72
PropFB	-3.65	5.09	-0.18	-0.72	0.48	-5.87	4.28	-0.28	-1.37	0.18
ProppopBachlor	-11.50	9.42	-0.27	-1.22	0.23	11.62	12.59	0.26	0.92	0.36
ProppopGradProf	20.11	13.17	0.44	1.53	0.13	x	x	x	x	x
Propemply16above	-2.65	3.44	-0.26	-0.77	0.44	x	x	x	x	x
PropQuaternary	-2.33	5.29	-0.14	-0.44	0.66	x	x	x	x	x
MedHHIadj	0.00	0.00	-0.30	-1.45	0.15	x	x	x	x	x
Propvacanthousing	-4.70	6.10	-0.09	-0.77	0.45	0.89	5.40	0.02	0.17	0.87
MedHouseValueadj	0.00	0.00	0.27	1.38	0.17	0.00	0.00	0.21	1.15	0.25
R Square	Model: OLS I : 0.65					Model: OLS II – FINAL MODEL: 0.61				

Regression Equation for Non-EPSCOR States is:

Y (Non-EPSCoR States) = 9.82-0.524*(AAOadj) -0.003*(ADVSandE)-0.075*(BWF) + 0.029*(SandEHED) + 0.252*(SandEGRAD)-1.897*(TimeDummy) – 0.011*(totpopinM) -5.872*(PropFB)+ 11.621*(ProppopBachlor)+ 0.890*(Propvacanthousing) ....(3)

Where

Y is the dependent variable

9.82 is constant

AAOadj is academic RandD at the level of non-EPSCoR states

ADVSandE is Advanced SandE degrees as share of SandE degrees conferred for non-EPSCoR states

SandEHED is SandE degrees as share of higher education degrees conferred for non-EPSCoR states

SandEGRAD is SandE graduate students per 1,000 individuals 25–34 years old for non-EPSCoR states

TimeDummy is Time Dummy for non-EPSCoR states

TotpopinM is Total Population (in Millions) for non-EPSCoR states

PropFB is Proportion of Foreign Born for non-EPSCoR states

ProppopBachlor is Proportion of Population with Bachelor's degree for non-EPSCoR states

Propvacanthousing is Proportion of Vacant Housing Units for non-EPSCoR states

5.5.0 Regression Analysis and Models for Land Grant Institutions

Having conducted regression models at the level of states, three more regression models are presented at the level of land grant institutions. While the broad rationale of conducting regression analysis is similar to the previous three models, the specific aim of conducting regression analysis at the scale of land grant institutions is to explain if changes in independent variables such as (Time Dummy, Proportion of Foreign Born, Proportion of Population with some College or Associateship, Proportion of Population with Bachelor's degree, Proportion of Population with graduate/ professional degree, Proportion of Employed Population 16 years and above in Tertiary Sector, Per Capita Income (Adjusted), Proportion of Vacant Housing Units, Median Housing Value (Adjusted)) can explain variance in the dependent variable i.e. RandDExpatUCadj -- Research and Development Expenditures at Universities and Colleges (Adjusted).

5.5.1 Model IV: Explaining All Land Grant Institutions

This model has been constructed to explore the general implications of increased RandD expenditures at universities and colleges for basic and applied research in SandE fields, and to observe how if at all, variations in socio-economic and demographics, higher education, household incomes may or may not explain changes at the level of land grant institutions in all states. Using ordinary least squares (OLS) regression, the following models tests, the relationship between RandD expenditure and other variables of socio-economic and demographics, higher education and household incomes:

Y(LGI-All States) = 1749961.715 – 658041.270*(TimeDummy) – 2110213.104*(PropFB) + 2621392.964*(ProppopSomeCorA) – 4736313.635*(ProppopBachlor) + 6330326.136 (ProppopGradProf) – 1486478.803*(PropTertiary) – 35.510*(percapitalNadj) + 1.367*(Propvacanthousing) + 5.198*(MedHouseValueadj) .... (4)

Where

Y is the dependent variable

1749961.715 is constant

TimeDummy is time dummy for LGI-All States

PropFB is proportion of foreign born for LGI-All States

ProppopSomeCorA is proportion of population with some college or associateship for LGI-All States

ProppopBachlor is proportion of population with bachelor's degree for LGI-All States

ProppopGradProf is proportion of population with graduate/ professional degree for LGI-All States

PropTertiary is proportion of employed population 16 years and above in tertiary sector for LGI-All States

percapitaINadj is per capita income (Adjusted) for LGI-All States

Propvacanthousing is Proportion of Vacant Housing Units for LGI-All States

MedHouseValueadj is median housing value (Adjusted) for LGI-All States

Table 5.5.1

Regression Model for All Land Grant Institutions

Final Model (All LGI)	Und. Cof.		St. Cof.		
Variables	B	Std. Err	Beta	T	Sig.
(Constant)	1749961.715	576980.753		3.033	0.003
TimeDummy	-658041.270	163172.630	-1.126	-4.033	0.000
PropFB	-2110213.104	1117902.805	-0.257	-1.888	0.061
ProppopSomeCorA	2621392.964	865087.951	0.277	3.030	0.003
ProppopBachlor	-4736313.635	1846835.170	-0.338	-2.565	0.011
ProppopGradProf	6330326.136	2266731.363	0.442	2.793	0.006
PropTertiary	-1486478.803	379876.205	-0.778	-3.913	0.000
percapitaINadj	-35.510	13.009	-0.359	-2.730	0.007
Vacanthousing	1.367	0.181	0.641	7.571	0.000
MedHouseValueadj	5.198	0.858	0.803	6.060	0.000
R Square		0.529			

An examination of the statistical details from the model in Table 5.5.1, it can be observed that while a large number of variables carry inconsistent signs on their B and Beta coefficients even in the final adopted model. Surprisingly, 7 out of 9 variables when diagnosed and cross verified with their corresponding correlation matrix in Table 5.3.1 are found to be significant.

5.5.2 Model V: Explaining EPSCoR Land Grant Institutions

While the above models have been generated using OLS, in the current model stepwise approach is applied for in doing so this model identified almost all variables as statistically significant.

Table 5.5.2

Regression Model for EPSCoR Land Grant Institutions

	Und. Cof.		St. Cof.		
	B	Std. Err	Beta	t	Sig.
(Constant)	279209.32	98571.83		2.83	0.006
totpopinM	37517.48	6011.26	0.74	6.24	0.000
PropFB	-569155.12	232410.62	-0.33	-2.45	0.017
ProppopBachlor	-909643.35	294944.37	-0.37	-3.08	0.003
ProppopGradProf	1918340.23	559957.73	0.56	3.43	0.001
PropSecondary	-510388.30	144120.49	-0.63	-3.54	0.001
PropQuinary	-1549551.00	611769.71	-0.38	-2.53	0.014
MedHHIadj	16.42	4.23	2.00	3.89	0.000
percapitaINadj	-35.27	9.91	-2.01	-3.56	0.001
R Square	0.441				

The equation for this model is:

Y (LGI-EPSCoR States) = 279209.32 + 37517.48 * (totpopinM) -569155.12 * (PropFB) - 909643.35* (ProppopBachlor) + 1918340.23*(ProppopGradProf) - 510388.30*(PropSecondary) – 1549551* (PropQuinary) + 16.42 * (MedHHIadj) – 35.27*(percapitaINadj) .... (5)

Where Y is the dependent variable

279209.32 is constant

totpopinM is Total Population (in Millions) for LGI-EPSCoR States

PropFB is proportion of foreign born for LGI-EPSCoR States

ProppopBachlor is proportion of population with bachelor's degree for LGI-EPSCoR States

ProppopGradProf is proportion of population with graduate/ professional degree for LGI-EPSCoR States

PropSecondary is Proportion of Employed Population 16 years and above in Secondary Sector for LGI-EPSCoR States

PropQuinary is Proportion of Employed Population 16 years and above in Quinary Sector for LGI-EPSCoR States

MedHHIadj is Median Household Income (Adjusted) for LGI-EPSCoR States

PercapitaINadj is per capita income (Adjusted) for LGI-EPSCoR States

Interestingly, most variables in the regression model (Table 5.5.2), when cross examined with the Pearson correlation (Table 5.3.2), display low association between RandD expenditures at universities and colleges and other variables. This model also shows that 2 out of 8 variables carry inconsistent signs and yet stepwise backward regression does reinforce the significance of variables such as PropFB, ProppopBachlor, ProppopGradProf, PropSecondary, PropQuinary, MedHHIadj, percapitaINadj. In terms of r-square i.e. 0.44 the fifth regression model is the weakest of all the models.

5.5.3 Model VI: Explaining Non-EPSCoR Land Grant Institutions

Like the above models, in this last model, once again OLS regression is used to explain the causal relationship between the dependent variable RandD expenditures at universities and colleges and the independent variables TimeDummy, ProppopBachlor, ProppopGradProf, PropTertiary, percapitalNadj, MedHouseValueadj and Propvacanthousing. As such this model is expressed in terms of the following equation:

Y (LGI-Non EPSCoR States) = 6477557.97 - 1034079.85 * (TimeDummy) - 10095138.49 * (ProppopBachlor) + 2820995.05 * (ProppopGradProf) - 3250987.30 * (PropTertiary) - 109.66 * (percapitalNadj) + 11.49 * (MedHouseValueadj) + 366891.78* (Propvacanthousing) .... (6)

Where Y is dependent variable

6477557.97 is constant

TimeDummy is Time Dummy for LGI-non EPSCoR States

ProppopBachlor is proportion of population with bachelor's degree for LGI-non EPSCoR States

ProppopGradProf is proportion of population with graduate/ professional degree for LGI-non EPSCoR States

PropTertiary is proportion of employed population 16 years and above in tertiary sector for LGI- non EPSCoR States

PercapitalNadj is per capita income (Adjusted) for LGI-non EPSCoR States

MedHouseValueadj is median housing value (Adjusted) for LGI-non EPSCoR states

Propvacanthousing is Proportion of Vacant Housing Units for LGI-non EPSCoR States

Table 5.5.3

Regression Model for Non-EPSCoR Land Grant Institutions

	Model: OLS - FINAL MODEL				
	Und. Cof.		St. Cof.		
	B	Std. Err	Beta	t	Sig.
(Constant)	6477557.97	1201645.71		5.39	0.000
TimeDummy	-1034079.85	220299.06	-1.33	-4.69	0.000
ProppopBachlor	-10095138.49	2819843.81	-0.55	-3.58	0.001
ProppopGradProf	2820995.05	2986583.46	0.17	0.94	0.348
PropTertiary	-3250987.30	654436.50	-1.29	-4.97	0.000
percapitalNadj	-109.66	29.96	-0.81	-3.66	0.000
MedHouseValueadj	11.49	1.12	1.37	10.23	0.000
Propvacanthousing	366891.78	2320532.05	0.01	0.16	0.875
R Square	0.634				

5.6 Shift-Share Analysis

Since one of the aims of this study is to dissect growth and change in SandT indicators among EPSCoR states vis-à-vis non-EPSCoR states, shift-share analysis technique comes as a useful tool. This technique describes, analyzes and explains regional economic change by disaggregating at regional and at the level of industrial sectors to study national economic change usually measured in employment numbers (Knudsen 2000; Sui 1995).

Shift-share analysis is one way to explain local employment change. It facilitates the understanding of employment concentration in certain industries at different scales and sectors than the nation as a whole. This technique involves partitioning employment change into that due to national trends, industrial sector trends and local conditions. The growth or decline of any industrial sector in a region is because of several reasons. Quite often the reason is rooted in the regions industrial structure. For example, a state or a region might display employment gains or losses across industries. An examination of the regional employment market will merely explain the employment change that is occurring in the region. However, in understanding local economic conditions by separating the local growth factors, from the national growth factors one can isolate industries that require our focus (Fothergill and Gudgin 1979; Hanham and Banasick 2000).

Shift-share analysis is thus used to decompose employment change within a regions economy over a specified period of time into mutually exclusive factors: firstly, national growth component, i.e. local growth (or decline) stimulated by national growth (decline); secondly, industrial mix component, i.e. local growth (decline) stimulated because of a local concentration of businesses in relatively faster (slower) growth economic sectors; and thirdly, competitive share component where local growth (decline) arises from more (less) competitive firms locally than the national average for that sector (Fothergill and Gudgin 1979; Hanham and Banasick 2000).

Shift-share analysis technique is a descriptive tool, i.e. it does not explain why employment changed, however, it is simply a starting point for further analysis. By measuring shift in the local economy into faster or slower growth sectors, it allows this dissertation research to corroborate the findings of its ranking analysis and correlation and regression analysis by isolating the national and local employment conditions which better situates this researcher in performing a robust analysis of spatial distribution of SandT indicators across EPSCoR and non-EPSCoR states.

In computing shift-share, there are three broad steps. Firstly, to calculate the national growth component (NG), secondly to calculate the industrial mix component

(IM), and thirdly, to calculate the competitive share component (CS). The NG measures the potential change in local employment, assuming that the local economy in this case, *states*, is similar to the national economy. NG is calculated by multiplying the base year employment in each sector with the national average employment growth rate, and then summing it over all the sectors. Results are then obtained which show how many new jobs were created locally due to national economic trends, assuming the local and national economies are identical. A positive IM indicates that the majority of local employment is in sectors growing faster than the national total employment, whereas a negative IM indicates just the opposite. This is expressed by the following equation:

National Growth Component = Base Employment X National Growth Rate

Computing Industrial Mix Component involving multiplying the Local Employment in each economic sector with the difference in the National Growth Rate for that sector and the Growth Rate for the whole economy. It is expressed as follows:

Industrial Mix Component = Base Employment X (Sector Growth Rate – National Average Growth Rate)

Finally, Competitive Share Component measures the ability of the local economy to capture an increasing or decreasing share of a particular sector's growth. This is computed by multiplying the local employment in each economic sector with the difference in the growth rate of that sector nationally and locally. Upon doing this for all the sectors, the results are summed over to give the value of the state's competitive share. Thus, a positive competitive share indicates that the states gained additional jobs over that, due to national growth and its industrial structure. This suggests that the state is more competitive or efficient in securing additional employment than the rest of the nation. A better understanding of competitive share is obtained by examining the same for both, the state, and its specific sectors. The CS component is expressed as follows:

Competitive Share Component = Base Employment X (Local Sector Growth Rate – National Sector Growth Rate)

5.7 Analyzing National and State-level Changes through Shift Share Results

It is evident from Table 5.6.1 that there has been substantial decline during 1995-2005 in the overall share of manufacturing jobs (-32.09%), and trade/transportation, etc (-24.19%). The construction industry has shown substantial contribution (38.05%). The service sector has shown a leap bound increase of 129.11%, whereas the government sector jobs increased by 11.79% only.

Table 5.6.1

Shift-Share Analysis (National Growth Component-Sector Wise Overall)

US Employment (in thousands)	1995	2005	Percent Change
Total of Sectors	101,992.60	1E+05	**15.27**
Construction	5089.1	7026	38.05
Manufacturing	18502.4	12565	-32.09
Trade, Transportation, and Utilities	33065.9	25068	-24.19
FIRE	6863.6	7601	10.75
Services	19003.3	43539	129.11
Government	19468.3	21763	11.79

Overall, the national growth component has shown a change of 15.27%. While the national level sectoral change in jobs is summarized in the Table 5.6.1, the shift-share analysis decomposes local industry employment change into three components, and is illustrated in Tables 5.6.3, 5.6.4 and 5.6.5.

Table 5.6.2 illustrates sectoral changes in employment over the period 1995-2005 for all states. In particular, the performance of EPSCoR states is not only dismal, but also marginal when compared with employment growth in Non-EPSCoR states. The overall change in employment within EPSCOR states has been marginal. The sectors of manufacturing and trade/transportation have registered negative growth across all the states; however, the positive change in employment in service-sector has not been fully compensated. Nevada is the only EPSCoR state that has been performing comparable to the Non-EPSCoR states, with its overall employment change at 33.6%, with a loss of employment in manufacturing has been compensated by nearly a 127.6% positive change in construction, 34.99% positive change in service-sectors, and 49.42% positive change in government employment. As has been discussed earlier in Chapter 5 (section 5.1), the performance of Non-EPSCoR states, such as California and Michigan with regards to output indicators like SandE Doctorates conferred, Patents awarded, and Venture Capital disbursed, completely mirrors the employment scenario during the period with its extremely high growth rate of 49% and 28%, respectively.

Table 5.6.2

Percent Change in Sectors of Employment, 1995-2005

States	Total	Const.	Manuf.	Tr.Trn.& Utl.	FIRE	Services	Govt.
Alabama	-37.35	25.53	-100.00	-22.38	23.74	-57.05	5.08
Alaska	5.27	35.34	-100.00	-19.72	23.53	50.51	10.96
Arizona	5.01	70.08	-10.78	-100.00	48.30	73.64	42.36
Arkansas	3.77	16.37	-22.35	-19.80	21.56	48.67	16.29
California	49.83	91.05	-12.98	-19.00	18.66	774.83	13.29
Colorado	14.02	53.70	-20.13	-25.16	40.92	51.30	20.13
Connecticut	-16.95	29.45	-30.05	-23.36	4.23	-28.01	10.58
Delaware	3.86	55.93	-100.00	-13.31	10.67	72.63	17.03
Dist.of Columbia	-32.52	23.96	-100.00	-100.00	-100.00	-24.97	-11.70
Florida	45.63	65.90	-20.18	-17.24	33.13	218.61	18.42
Georgia	-17.25	30.45	-100.00	-21.02	25.88	7.86	12.90
Hawaii	-15.77	9.71	-8.72	-35.92	-100.00	6.25	5.03
Idaho	-1.82	32.47	-18.96	-17.29	-100.00	22.51	21.70
Illinois	20.22	23.99	-27.37	-27.52	0.86	274.52	8.98
Indiana	1.84	15.27	-15.24	-27.66	9.59	49.12	10.03
Iowa	-7.25	19.86	-9.84	-21.83	25.71	-10.40	7.28
Kansas	-26.76	22.88	-6.20	-27.40	-100.00	-60.33	5.07
Kentucky	6.26	18.47	-14.62	-20.10	34.96	47.40	8.21
Louisiana	2.70	8.52	-20.95	-27.57	27.25	38.04	6.67
Maine	9.48	52.20	-32.58	-19.31	28.73	55.03	14.99
Maryland	9.75	42.35	-21.25	-24.65	19.00	42.30	9.13
Massachusetts	1.90	53.88	-30.26	-28.27	4.63	35.48	2.37
Michigan	28.40	25.15	-30.20	-29.12	11.55	1476.62	7.61
Minnesota	7.45	54.72	-17.92	-22.67	28.09	41.92	13.92
Mississippi	-22.31	0.41	-31.06	-18.37	-100.00	-41.69	10.85
Missouri	-0.49	18.57	-27.08	-30.13	12.43	37.33	10.60
Montana	12.07	56.52	-18.30	-25.45	32.91	53.58	13.54
Nebraska	7.83	41.14	-11.85	-21.60	21.92	46.28	6.51
Nevada	33.60	127.60	-100.00	10.99	82.66	34.99	49.42
New Hampshire	-4.83	46.34	-19.88	-9.57	33.33	-17.49	20.28
New Jersey	46.32	32.18	-33.73	-19.17	21.38	2627.32	12.51
New Mexico	11.65	13.35	-22.20	-27.90	13.92	51.79	21.31
New York	34.82	24.16	-38.14	-25.24	-4.40	571.05	5.59
North Carolina	0.05	29.63	-33.64	-22.73	-100.00	67.14	18.86
North Dakota	5.52	27.27	11.42	-25.03	34.29	25.12	13.15
Ohio	23.05	10.15	-24.18	-29.20	15.80	435.91	7.27
Oklahoma	-4.73	27.31	-100.00	-27.34	31.06	45.35	12.97
Oregon	8.98	29.03	-10.45	-22.40	10.11	50.30	15.56
Pennsylvania	25.51	20.78	-27.41	-22.09	7.27	271.38	3.82

Table 5.6.2 (continued)

Rhode Island	4.77	51.82	-35.17	-29.30	37.80	46.74	5.98
South Carolina	-21.27	31.76	-100.00	-19.17	35.32	8.74	11.68
South Dakota	-11.82	33.11	-100.00	-24.78	54.89	9.53	11.76
Tennessee	-25.69	13.85	-100.00	-18.40	31.63	-8.34	12.06
Texas	54.08	34.80	-12.96	-17.41	34.04	8945.11	15.96
Utah	12.22	45.10	-2.33	-15.10	-100.00	58.80	22.89
Vermont	-52.27	42.74	-16.48	-102.68	-100.00	-72.01	17.78
Virginia	9.43	40.99	-25.99	-23.02	13.88	51.82	8.77
Washington	7.14	30.16	-21.50	-25.05	21.96	44.21	18.26
West Virginia	-1.05	0.28	-24.37	-30.75	17.31	34.44	6.57
Wisconsin	4.13	29.27	-15.52	-22.70	15.37	40.48	14.20
Wyoming	-10.63	30.14	-100.00	-24.54	-100.00	3.49	11.53

(Horizontally shaded cells are EPSCoR States)

When considering the sectoral changes across all the states in US, it is observed a negative percent change in overall employment in most EPSCoR states such as Alabama (-37.35), Vermont (-52.27), Tennessee (-25.69), South Carolina (-21.27), South Dakota (-11.82) and Wyoming (10.63). It is also evident that majority of Non-EPSCoR states are doing very well, as is obvious from positive change in overall employment. Some of the highest ranking Non-EPSCoR states for overall employment growth are Texas (54.08%), California (49.83%), Florida (45.63%), New Jersey (46.32%), and New York (34.82%).

Even typical rust belt states, such as Michigan has shown a positive change of 28.40%, Ohio 23.05%, and Pennsylvania 25.51%. These are also indicative of the changing trends within the growth of sectoral jobs that might have shifted during the course of time, and the concomitant preparedness of these rustbelt states to develop and grow in non-manufacturing, tertiary and quaternary-based occupations. Employment shift from manufacturing sectors towards the service sectors for these rust belt states also display a high growth in service sectors, with Michigan (1476.62%), Ohio (435.91%), and Pennsylvania (271.38%). The decline in manufacturing employment in these states are Michigan (-30.20%), Ohio (-14.18%), and Pennsylvania (-27.41%). This essentially displays an effort on the part of these states to shift from a mass production region to a knowledge region (Calzonetti and Gatrell 2000).

Table 5.6.2 is very informative as it also shows the sectoral changes across all US states. It is an interesting pattern that states, such as Alabama, Alaska, DC, Delaware, Georgia, Nevada, Oklahoma, South Carolina, South Dakota, Tennessee and Wyoming have displayed 100% negative change in manufacturing jobs during 1995-2005. Another interesting observation is that nine out of ten of these listed states are EPSCoR states, further indicating that employment growth in manufacturing sector has diminished totally, while concomitant growth of employment in other sectors have not complimented the overall job loss. This substantiates the poor performance of EPSCoR states. It may be recalled from Section 3.2 and Table 3.1, and observations in Section 5.1 that the state of Rhode Island which was a late comer into the EPSCoR program, having joined in 2004, registered an increase of 46.74% in service sector. Similar observations can also be made for the state of Delaware that entered EPSCoR program in 2003, and its service-sector employment has registered an increase of 72.36%. It is also interesting to note that while the overall employment change is marginal, the service sector in particular has outperformed across all states.

Table 5.6.3 illustrates the national growth share, which refers to the local job growth attributing to national economic growth, i.e. if the nation is experiencing employment growth, it is reasonable to expect that this growth will positively influence states. Among EPSCoR states, the NG of Nevada is 114.04, indicating that 114 out of a total of 251 new jobs created in all sectors were created due to national economic trends. Likewise, the service sector in Nevada has a NG of 51.72, implying that 52 out of 118 jobs in service sector were due to national economic trends.

An examination of Table 5.6.3 also highlights that while there has been a clear trend of national employment growth across all states, in particular the EPSCoR states have shown employment losses, for example, Alabama (-657), Kansas (-315), Mississippi (-235), South Carolina (-343), and Tennessee (-632). This also suggests that the above mentioned EPSCoR states are not performing as well as the national average. The other components of the shift-share analysis will help identify why this is happening. On the other hand, the Non-EPSCoR states, such as California, Florida, Illinois, New Jersey, Michigan, New York, Ohio, Pennsylvania, Texas, etc. display a trend where the national growth component is clearly contributing substantially towards their overall employment growth. For example, California's 1392 jobs out of 4543 total jobs were attributed to national economic development. Similarly, these figures for Florida were 750 out of 2240, for Illinois it was 687 out of 910, for Michigan it was 491 out of 912, New Jersey it was 394 out of 1194, New York it was 889 out of 2027 total jobs, Ohio it was 630 out of 951 total jobs, Pennsylvania it was 643 out of 1073, and for Texas 873 out of 3090 total jobs. These statistics completely mirror the dismal picture painted by ranking analysis earlier in this Chapter, as also in the narratives provided in Chapter 3.

Table 5.6.3

Shift-Share Analysis (National Growth Component – State-wise)

States	Construction		Manufacturing		Trade, Transp. & Utilities		FIRE		Services		Govt.		St. Natn. Growth Comp.	New Jobs in All Sectors
	Local Empl. 1995	Natl. Grw. Comp	Local Empl. 1995	Natl. Grw. Comp	Local Empl. 1995	Natl. Grw. Comp	Local Empl. 1995	Natl. Grw. Comp	Local Empl. 1995	Natl. Grw. Comp	Local Empl. 1995	Natl. Grw. Comp		
Alabama	85	12.98	390.4	59.61	487	74.36	77.1	11.77	376.5	57.49	342.7	52.33	268.55	-656.8
Alaska	13.3	2.03	16.8	2.57	77.6	11.85	11.9	1.82	59	9.01	73.9	11.28	38.56	13.3
Arizona	117.3	17.91	197.5	30.16	512.6	78.27	111.6	17.04	492.5	75.20	286.1	43.69	262.28	86.1
Arkansas	44.6	6.81	262.2	40.04	301.5	46.04	42.2	6.44	233.2	35.61	173.7	26.52	161.46	39.9
California	455.8	69.60	1767.8	269.94	3424.1	522.86	773.5	118.1	591.6	90.34	2103.7	321.2	1392.09	4542.5
Colorado	101.3	15.47	194.2	29.65	548.9	83.82	111.2	16.98	517.2	78.98	301	45.96	270.86	248.6
Connecticut	52.3	7.99	282.5	43.14	404.1	61.71	134.8	20.58	453.7	69.28	219.3	33.49	236.18	-262.1
Delaware	17.7	2.70	63.1	9.64	93.9	14.34	40.3	6.15	91.7	14.00	50.5	7.71	54.54	13.8
D. Columbia	9.6	1.47	13.1	2.00	73.8	11.27	31.1	4.75	259.5	39.63	262.3	40.05	99.16	-211.2
Florida	308.2	47.06	485.6	74.15	1835.3	280.25	381.5	58.26	986.7	150.7	911.6	139.2	749.59	2240
Georgia	151.7	23.16	586.7	89.59	1044.2	159.45	176.6	26.97	816.4	124.7	568.3	86.78	510.61	-576.8
Hawaii	27.8	4.25	17.2	2.63	176.8	27.00	38.2	5.83	164.9	25.18	111.4	17.01	81.89	-84.6
Idaho	30.8	4.70	74.9	11.44	142.3	21.73	24.2	3.70	106.6	16.28	94	14.35	72.20	-8.6
Illinois	212.2	32.40	956.4	146.04	1618.3	247.11	395.1	60.33	544	83.07	775.9	118.5	687.44	910.2
Indiana	131.6	20.10	678.5	103.61	800.8	122.28	128.3	19.59	618.9	94.51	390.8	59.68	419.76	50.7
Iowa	56.9	8.69	249	38.02	391.6	59.80	77.8	11.88	332.7	50.80	226.6	34.60	203.79	-96.8
Kansas	50.7	7.74	191.9	29.30	356.6	54.45	58.6	8.95	282.1	43.08	236.7	36.14	179.67	-314.8
Kentucky	72	10.99	310.5	47.41	469.7	71.72	63.5	9.70	379.3	57.92	286.1	43.69	241.43	99
Louisiana	109.2	16.67	191.9	29.30	528.5	80.70	81.1	12.38	466.6	71.25	358.3	54.71	265.03	46.9
Maine	20.5	3.13	92.7	14.16	156.9	23.96	26.8	4.09	143.2	21.87	91.4	13.96	81.16	50.4
Maryland	126.1	19.26	178.8	27.30	624	95.28	132.1	20.17	674.2	102.9	424.1	64.76	329.73	210.6
Massachusetts	91.5	13.97	448.1	68.42	801.9	122.45	209.6	32.01	985.4	150.5	395.9	60.45	447.78	55.7
Michigan	152.7	23.32	977.6	149.28	1151.8	175.88	195.7	29.88	97.1	14.83	639.7	97.68	490.87	912.9
Minnesota	81.5	12.45	421.8	64.41	684.1	104.46	138.5	21.15	645	98.49	363.4	55.49	356.45	173.8

Table 5.6.3 (Continued)

Mississippi	48.7	7.44	259.2	39.58	270	41.23	39	5.96	215.4	32.89	220.2	33.62	160.72	-234.8
Missouri	114.7	17.51	425.8	65.0	764.6	116.75	147.2	22.48	675.8	103.2	390.6	59.64	384.6	-12.4
Montana	16.1	2.46	23.5	3.6	115.5	17.64	15.8	2.41	93.7	14.31	76.8	11.73	52.1	41.2
Nebraska	33.3	5.08	112.2	17.1	252.8	38.60	52	7.94	208.1	31.78	150.5	22.98	123.5	63.3
Nevada	55.8	8.52	34.8	5.3	188.4	28.77	34.6	5.28	338.7	51.72	94.5	14.43	114.0	250.9
N. Hampshire	20.5	3.13	101.1	15.4	155.7	23.78	29.4	4.49	146.4	22.36	77.4	11.82	81.0	-25.6
New Jersey	126.8	19.36	506.3	77.3	1091.6	166.69	231.1	35.29	53.8	8.22	570	87.04	393.9	1194.9
New Mexico	45.7	6.98	46.4	7.1	191.4	29.23	30.9	4.72	184.2	28.13	165.2	25.23	101.4	77.3
New York	257.5	39.32	950.3	145.1	1983.8	302.93	736.3	112.4	487.1	74.4	1406.3	214.7	888.9	2026.9
N. Carolina	171.8	26.23	868.2	132.6	937.6	143.17	144.3	22.03	739.7	112.9	549.9	83.97	520.9	1.7
North Dakota	13.2	2.02	21.9	3.4	96.7	14.77	14	2.14	82.8	12.64	66.9	10.22	45.12	16.3
Ohio	213.7	32.63	1087.8	166.1	1460.8	223.06	270.9	41.37	349.2	53.32	743.1	113.47	629.9	951.1
Oklahoma	49.8	7.60	173.6	26.5	379.7	57.98	64.4	9.83	328.3	50.13	269.8	41.20	193.3	-59.9
Oregon	65.8	10.05	225.8	34.5	422.3	64.49	89	13.59	354.7	54.16	237.2	36.22	212.9	125.2
Pennsylvania	206.4	31.52	947.9	144.7	1446.5	220.88	312.3	47.69	574.8	87.77	720.4	110.01	642.6	1073.7
Rhode Island	13.7	2.09	87	13.3	111.6	17.04	25.4	3.88	136.3	20.81	61.9	9.45	66.56	20.8
S. Carolina	85	12.98	374.3	57.2	440.7	67.29	68.8	10.51	348	53.14	294.4	44.95	246.0	-342.7
South Dakota	14.8	2.26	45.9	7.0	102.9	15.71	18.4	2.81	89.2	13.62	67.2	10.26	51.6	-40
Tennessee	105.4	16.09	542.2	82.8	716.4	109.39	109.4	16.71	614.9	93.90	369.7	56.45	375.3	-631.5
Texas	403.5	61.61	1019.7	155.7	2371.3	362.10	448	68.41	34.8	5.31	1436.9	219.41	872.6	3090.2
Utah	51	7.79	120.1	18.3	263.5	40.24	47.6	7.27	233.5	35.66	162.5	24.81	134.1	107.3
Vermont	11.7	1.79	44.3	6.8	74.7	11.41	12.2	1.86	76.1	11.62	45	6.87	40.3	-138
Virginia	169.8	25.93	404.4	61.8	851.6	130.04	167.1	25.52	855.1	130.6	601	91.77	465.6	287.5
Washington	126	19.24	341.9	52.2	703.3	107.39	124.3	18.98	613.9	93.74	443.1	67.66	359.2	167.9
West Virginia	35.1	5.36	82.9	127	199.7	30.49	26	3.97	177.7	27.13	135.4	20.68	100.3	-6.9
Wisconsin	98.4	15.03	595.5	90.9	700.9	107.03	136	20.77	627.2	95.77	366.9	56.03	385.6	104.2
Wyoming	14.6	2.23	10.2	1.5	65.6	10.02	7.9	1.21	45.9	7.01	58.1	8.87	30.9	-21.5

(Horizontally shaded cells are EPSCoR States)

The observed industrial mix component data as shown in Table 5.6.4 determines whether the local economy is concentrated in industries that are growing slower or faster than the national average. An interesting observation emerging from the industrial mix component is that the IMC for both, services and construction sectors are positive across all states. On the other hand, for many states the IMC for manufacturing, FIRE, trade / transportation / utilities, and government are negative. A broad conclusion that may be arrived is that both construction and service sectors contribute towards the overall growth of the state's economy. However, that growth in construction and services is often offset by the negative growth in sectors, such as manufacturing, FIRE, trade / transportation / utilities, and government, which are growing slower than the national average.

A negative IMC indicates that independent of national influences, the local sectors, on balance, grow slower than the national average, and reduce employment growth. If the IMC is positive, as is the case in construction and services, it would suggest that the state economy has relatively more people in fast growth sectors than the national average. For example, all EPSCoR states show negative IMC for sectors, such as manufacturing, trade/transportation/utilities, FIRE and government, indicating the cause for their overall slow growth. There are substantial policy suggestions for pursuing growth in the service and construction sectors which intrinsically also imply growth and development for science and technology indicators (Calzonetti and Gatrell 2000; Gatrell 1999; Hauger 2004).

Table 5.6.4

Shift-Share Analysis (Industrial Mix Component)

	Construction		Manufacturing		Trade, Transp. & Util.		FIRE		Services		Govt.	
	Local Empl. 1995	IMC	Local Empl. 1995	IMC	Local Empl. 1995	IMC	Local Empl. 1995	IMC	Local Empl. 1995	IMC	Local Empl. 1995	IMC
Alabama	85	19.36	390.4	-184.89	487	-192.17	77.1	-3.48	376.5	428.61	342.7	-11.96
Alaska	13.3	3.03	16.8	-7.96	77.6	-30.62	11.9	-0.54	59	67.17	73.9	-2.58
Arizona	117.3	26.72	197.5	-93.54	512.6	-202.27	111.6	-5.04	492.5	560.66	286.1	-9.98
Arkansas	44.6	10.16	262.2	-124.18	301.5	-118.97	42.2	-1.91	233.2	265.47	173.7	-6.06
California	455.8	103.83	1767.8	-837.23	3424.1	-1351.15	773.5	-34.96	591.6	673.48	2103.7	-73.42
Colorado	101.3	23.08	194.2	-91.97	548.9	-216.60	111.2	-5.03	517.2	588.78	301	-10.50
Connecticut	52.3	11.91	282.5	-133.79	404.1	-159.46	134.8	-6.09	453.7	516.49	219.3	-7.65
Delaware	17.7	4.03	63.1	-29.88	93.9	-37.05	40.3	-1.82	91.7	104.39	50.5	-1.76
Dist. of Columbia	9.6	2.19	13.1	-6.20	73.8	-29.12	31.1	-1.41	259.5	295.41	262.3	-9.15
Florida	308.2	70.21	485.6	-229.98	1835.3	-724.21	381.5	-17.24	986.7	1123.26	911.6	-31.81
Georgia	151.7	34.56	586.7	-277.86	1044.2	-412.04	176.6	-7.98	816.4	929.39	568.3	-19.83
Hawaii	27.8	6.33	17.2	-8.15	176.8	-69.77	38.2	-1.73	164.9	187.72	111.4	-3.89
Idaho	30.8	7.02	74.9	-35.47	142.3	-56.15	24.2	-1.09	106.6	121.35	94	-3.28
Illinois	212.2	48.34	956.4	-452.95	1618.3	-638.58	395.1	-17.86	544	619.29	775.9	-27.08
Indiana	131.6	29.98	678.5	-321.34	800.8	-316.00	128.3	-5.80	618.9	704.56	390.8	-13.64
Iowa	56.9	12.96	249	-117.93	391.6	-154.53	77.8	-3.52	332.7	378.75	226.6	-7.91
Kansas	50.7	11.55	191.9	-90.88	356.6	-140.71	58.6	-2.65	282.1	321.14	236.7	-8.26
Kentucky	72	16.40	310.5	-147.05	469.7	-185.34	63.5	-2.87	379.3	431.80	286.1	-9.98
Louisiana	109.2	24.88	191.9	-90.88	528.5	-208.55	81.1	-3.67	466.6	531.18	358.3	-12.50
Maine	20.5	4.67	92.7	-43.90	156.9	-61.91	26.8	-1.21	143.2	163.02	91.4	-3.19
Maryland	126.1	28.73	178.8	-84.68	624	-246.23	132.1	-5.97	674.2	767.51	424.1	-14.80
Massachusetts	91.5	20.84	448.1	-212.22	801.9	-316.43	209.6	-9.47	985.4	1121.78	395.9	-13.82
Michigan	152.7	34.79	977.6	-462.99	1151.8	-454.50	195.7	-8.85	97.1	110.54	639.7	-22.33

Table 5.6.4 (Continued)

Minnesota	81.5	18.57	421.8	-199.76	684.1	-269.95	138.5	-6.26	645	734.27	363.4	-12.68
Mississippi	48.7	11.09	259.2	-122.76	270	-106.54	39	-1.76	215.4	245.21	220.2	-7.68
Missouri	114.7	26.13	425.8	-201.66	764.6	-301.71	147.2	-6.65	675.8	769.33	390.6	-13.63
Montana	16.1	3.67	23.5	-11.13	115.5	-45.58	15.8	-0.71	93.7	106.67	76.8	-2.68
Nebraska	33.3	7.59	112.2	-53.14	252.8	-99.75	52	-2.35	208.1	236.90	150.5	-5.25
Nevada	55.8	12.71	34.8	-16.48	188.4	-74.34	34.6	-1.56	338.7	385.58	94.5	-3.30
New Hampshire	20.5	4.67	101.1	-47.88	155.7	-61.44	29.4	-1.33	146.4	166.66	77.4	-2.70
New Jersey	126.8	28.89	506.3	-239.78	1091.6	-430.75	231.1	-10.45	53.8	61.25	570	-19.89
New Mexico	45.7	10.41	46.4	-21.98	191.4	-75.53	30.9	-1.40	184.2	209.69	165.2	-5.77
New York	257.5	58.66	950.3	-450.06	1983.8	-782.81	736.3	-33.28	487.1	554.51	1406.3	-49.08
North Carolina	171.8	39.14	868.2	-411.18	937.6	-369.98	144.3	-6.52	739.7	842.07	549.9	-19.19
North Dakota	13.2	3.01	21.9	-10.37	96.7	-38.16	14	-0.63	82.8	94.26	66.9	-2.33
Ohio	213.7	48.68	1087.8	-515.18	1460.8	-576.43	270.9	-12.24	349.2	397.53	743.1	-25.93
Oklahoma	49.8	11.34	173.6	-82.22	379.7	-149.83	64.4	-2.91	328.3	373.74	269.8	-9.42
Oregon	65.8	14.99	225.8	-106.94	422.3	-166.64	89	-4.02	354.7	403.79	237.2	-8.28
Pennsylvania	206.4	47.02	947.9	-448.93	1446.5	-570.79	312.3	-14.12	574.8	654.35	720.4	-25.14
Rhode Island	13.7	3.12	87	-41.20	111.6	-44.04	25.4	-1.15	136.3	155.16	61.9	-2.16
South Carolina	85	19.36	374.3	-177.27	440.7	-173.90	68.8	-3.11	348	396.16	294.4	-10.27
South Dakota	14.8	3.37	45.9	-21.74	102.9	-40.60	18.4	-0.83	89.2	101.55	67.2	-2.35
Tennessee	105.4	24.01	542.2	-256.79	716.4	-282.69	109.4	-4.94	614.9	700.00	369.7	-12.90
Texas	403.5	91.92	1019.7	-482.93	2371.3	-935.71	448	-20.25	34.8	39.62	1436.9	-50.15
Utah	51	11.62	120.1	-56.88	263.5	-103.98	47.6	-2.15	233.5	265.82	162.5	-5.67
Vermont	11.7	2.67	44.3	-20.98	74.7	-29.48	12.2	-0.55	76.1	86.63	45	-1.57
Virginia	169.8	38.68	404.4	-191.52	851.6	-336.04	167.1	-7.55	855.1	973.45	601	-20.97
Washington	126	28.70	341.9	-161.92	703.3	-277.52	124.3	-5.62	613.9	698.86	443.1	-15.46
West Virginia	35.1	8.00	82.9	-39.26	199.7	-78.80	26	-1.18	177.7	202.29	135.4	-4.73
Wisconsin	98.4	22.42	595.5	-282.03	700.9	-276.58	136	-6.15	627.2	714.00	366.9	-12.80
Wyoming	14.6	3.33	10.2	-4.83	65.6	-25.89	7.9	-0.36	45.9	52.25	58.1	-2.03

(Horizontally shaded cells are EPSCoR States)

Table 5.6.5

Shift-Share Analysis (Competitive Share Component)

	Construction	Manufacturing	Tr.,Tra. & Ut	FIRE	Services	Government
Alabama	-10.64	-265.12	8.81	10.01	-700.90	-23.00
Alaska	-0.36	-11.41	3.47	1.52	-46.37	-0.61
Arizona	37.57	42.08	-388.60	41.90	-273.17	87.47
Arkansas	-9.67	25.54	13.23	4.56	-187.58	7.82
California	241.57	337.79	177.59	61.15	3820.09	31.47
Colorado	15.86	23.22	-5.32	33.55	-402.46	25.11
Connecticut	-4.50	5.75	3.35	-8.79	-712.87	-2.66
Delaware	3.17	-42.85	10.21	-0.03	-51.79	2.65
Dist. of Columbia	-1.35	-8.90	-55.95	-34.44	-399.84	-61.63
Florida	85.83	57.83	127.56	85.39	883.07	60.42
Georgia	-11.52	-398.43	33.09	26.72	-989.85	6.30
Hawaii	-7.88	4.02	-20.73	-42.31	-202.60	-7.53
Idaho	-1.72	9.84	9.82	-26.80	-113.63	9.32
Illinois	-29.84	45.11	-53.93	-39.07	791.04	-21.78
Indiana	-29.97	114.33	-27.79	-1.49	-495.06	-6.88
Iowa	-10.35	55.40	9.23	11.64	-464.15	-10.22
Kansas	-7.69	49.68	-11.44	-64.90	-534.42	-15.91
Kentucky	-14.10	54.24	19.22	15.37	-309.91	-10.23
Louisiana	-32.25	21.38	-17.86	13.38	-424.93	-18.34
Maine	2.90	-0.45	7.65	4.82	-106.09	2.92
Maryland	5.42	19.38	-2.85	10.90	-585.26	-11.30
Massachusetts	14.48	8.20	-32.72	-12.83	-922.65	-37.28
Michigan	-19.70	18.51	-56.78	1.56	1308.43	-26.72
Minnesota	13.59	59.76	10.38	24.01	-562.36	7.76
Mississippi	-18.33	2.68	15.71	-43.19	-367.90	-2.06
Missouri	-22.34	21.34	-45.44	2.48	-620.23	-4.65
Montana	2.97	3.24	-1.46	3.50	-70.78	1.35
Nebraska	1.03	22.70	6.55	5.81	-172.38	-7.94
Nevada	49.97	-23.63	66.27	24.88	-318.80	35.56
New Hampshire	1.70	12.34	22.76	6.64	-214.62	6.57
New Jersey	-7.45	-8.33	54.76	24.56	1344.04	4.10
New Mexico	-11.29	4.59	-7.10	0.98	-142.42	15.72
New York	-35.78	-57.45	-20.82	-111.6	2152.71	-87.20
North Carolina	-14.47	-13.49	13.71	-159.8	-458.43	38.87
North Dakota	-1.42	9.53	-0.81	3.30	-86.10	0.91
Ohio	-59.61	86.08	-73.23	13.68	1071.35	-33.61
Oklahoma	-5.35	-117.89	-11.95	13.08	-274.97	3.19
Oregon	-5.94	48.86	7.55	-0.57	-279.55	8.93
Pennsylvania	-35.64	44.38	30.41	-10.87	817.78	-57.44

Table 5.6.5 (continued)

	Construction	Manufacturing	Tr.,Tra. & Ut	FIRE	Services	Government
Rhode Island	1.89	-2.68	-5.70	6.87	-112.28	-3.60
South Carolina	-5.34	-254.19	22.11	16.90	-418.90	-0.31
South Dakota	-0.73	-31.17	-0.61	8.12	-106.67	-0.02
Tennessee	-25.50	-368.21	41.50	22.84	-845.20	1.01
Texas	-13.13	195.02	160.82	104.34	3067.97	59.99
Utah	3.59	35.74	23.94	-52.72	-164.17	18.04
Vermont	0.55	6.92	-58.63	-13.51	-153.05	2.69
Virginia	4.99	24.67	10.00	5.24	-660.92	-18.16
Washington	-9.94	36.22	-6.07	13.94	-521.21	28.66
West Virginia	-13.26	6.40	-13.09	1.71	-168.23	-7.06
Wisconsin	-8.64	98.70	10.45	6.28	-555.88	8.84
Wyoming	-1.16	-6.93	-0.23	-8.75	-57.66	-0.15

(Horizontally shaded cells are EPSCoR States)

The competitive share component (CSC) determines whether local business are growing faster or slower than its national counterpart in the respective sectors. It is observed that in Table 5.6.5, in particular all EPSCoR states had CSC that is negative suggesting that they experience job losses beyond national growth trend, and their industrial mix. In other words, EPSCoR states created a lower share of employment growth than other states in the nation. Once again, shift-share analysis does not outline the reasons attributing to these patterns, but simply provides a descriptive overview of what is happening and where.

5.8 Discussions

This study examines the historical development of SandT indicators in EPSCoR states over the period 1993-94 to 2004-05. EPSCoR states have experienced changes in their economy as a result of economic restructuring. In the following discussion spatial distribution of SandT indicators at the state level is compared to those at the level of land grant institutions (LGIs). In universal terms the spatial distribution of SandT indicators and its concomitant impact on employment growth favors non-EPSCoR states, broadly, but for a few EPSCoR states. As Table 5.6.1 illustrates this trend is true in terms of input indicators such as RandD as share of gross domestic product and observed output in terms of number of SandE doctorates conferred, patents awarded and venture capital disbursed. In the following analysis the geographies of EPSCoR and non-EPSCoR states are examined more closely to understand the dynamics of the spatial distribution of SandT indicators across the 27 EPSCoR jurisdictions and 25 non-EPSCoR states. This is done by drawing upon the ranking, correlation, regression, and shift-share analyses results that have been discussed above.

In conducting ranking analysis, states with high ranking in research and development (RandD) as share of gross domestic product also tended to rank high on science and engineering doctorates conferred. States with high ranking for RandD also ranked high on patents awarded, and venture capital disbursed. It can be concluded that, RandD as an input has a strong association with indicators, such as numbers of doctorates, patents awarded, and venture capital disbursed. It is for this reason that in this research, RandD has been adopted as a proxy for the entire gamut of science and technology indicators. In the same spirit, the choice of independent variables in this study includes the following, Academic Article Output per $1 million of academic RandD by state (adjusted); Academic RandD per $1,000 of gross state product, by state (adjusted); Advanced SandE degrees as share of SandE degrees conferred; Average undergraduate charge at public 4-year institutions (adjusted); Bachelor's degree holders as share of workforce; SandE degrees as share of higher education degrees conferred; SandE graduate students per 1,000 individuals 25–34 years old; Time Dummy; Federally Financed Research and Development Expenditures at University and Colleges (Adjusted); Research and Development Expenditures at Universities and Colleges (Adjusted); Total Population (in Millions); Proportion of Foreign Born; Proportion of Population with High School Diploma or lesser; Proportion of Population with some College or Associateship; Proportion of Population with Bachelor's degree; Proportion of Population with graduate/ professional degree; Propemply16above: Proportion of Employed Population 16 years and above Proportion of Employed Population 16 years and above in Primary Sector; Proportion of Employed Population 16 years and above in Secondary Sector; Proportion of Employed Population 16 years and above in Tertiary Sector; Proportion of Employed Population 16 years and above in Quaternary Sector; Proportion of Employed Population 16 years and above in Quinary Sector; Median Household Income (Adjusted); Per Capita Income (Adjusted); Proportion of Vacant Housing Units; Median Housing Value (Adjusted).

From Pearson correlation, it was found that in different combinations, these variables displayed strong association with each other, as well as with the dependent variable ARandD in the study.

While analyzing final regression models (models 1 through VI) for All-States, and All-Land Grand Institutions, EPSCOR as well as Non-EPSCoR, it is found that (i) these are all statistically significant models; (ii) the *B* coefficients on the variables "Proportion of Population with graduate/ professional degree" and "Propemply16above" are very high and positive; (iii) and the *B* coefficient on TimeDummy in models I, II, III, IV, and

VI are all negative. A positive high *B* coefficient on the grads/professionals and employed demonstrates the competitiveness and productivity of graduates and professionals across scale, as also for EPSCoR and Non-EPSCoR states. Parallels can be drawn between the predictor PropGradProf which is positive and the high growth and contribution of the services sector as has been observed in shift-share analysis. More importantly, this demonstrates the real world consequences of economic restructuring-deindustrialization, reindustrialization, and the information age signaling the growth of the service sector and the creative class (Florida 2002, Gatrell 1999, 2002)

A negative *B* coefficient on Time Dummy indicates that across all these models, as time progresses, the academic RandD slows down, hence, the ability for academic RandD to explain overall science and technology indicators decreases over time. This suggests that there is a diminished return over time on investments made on academic RandD. This observation is based on the performance of the time variable across all regression models. This is an important finding as it applies to both scales, All-States as well as Land Grant Institutions. When comparing the *B* coefficients on the All States, EPSCOR and Non-EPSCoR states, the coefficients are -1.306 for All States, -1.333 for EPSCoR States, and -1.897 for Non-EPSCoR states. This further justifies that the diminishing influence is the strongest on Non-EPSCOR states, whereas EPSCoR States mirror the overall patterns across all states. When examining the *B* coefficients on Land Grant Institutions, the value for All-Land Grant Institutions is -658041.27, whereas for Non-EPSCoR states, it is -1034079.85, thus indicating the stringer diminishing influence on Non-EPSCoR Land Grant Institutions. One can see the similarities exhibited about the diminishing returns over time, which is much faster in Non-EPSCoR states compared to overall sample.

The same general trend is also observed in the case of academic article output, which in a sense is counterintuitive since it is expected that an increase in published research and citations has a positive impact on the growth of academic RandD. It also contradicts the broader perception in the location of spin offs from academic research discussed in Chapters 3 and 4.

In summary it can be said that the results of the analysis are consistent with the hypotheses and the research expectations and literature. Thus, the analysis demonstrates that there is a statistical relationship between SandT indicators as is observed among the EPSCoR states performance, which mirrors the countrywide performance at the level of states.

5.9 Limitations

In this study scale has emerged as a central idea both in terms of data gathering, analysis and policy perspective. Sometimes the issue of scale overlaps with that of policy implications, too. In so much, any discussion of scale is limited as the conceptual framework of EPSCoR is determined on a state level rather than at the individual or institutional level, as is more common among NSF programs.

Historically, both data and policy with regard to SandT in this country have been determined at the level of states since funding from the NSF and the federal governments at large have been provided at the state scale. However, the availability of data for empirical analysis cannot always be a good reason for restricting research at the state scale for there are studies wherein relevant data for research on strategic state SandT planning and policy have been conducted within states by collecting firm level data (Calzonetti and Gatrell 2000; Calzonetti, Allison and Gatrell 1999). However, this study shows that states are not too big to assess change but it is the challenges of the framework of time and financial resources which imposes its own demands. Hence, the issue of scale then emerges from the realm of social construction.

Yet, another limitation associated with data is the lack of consistent data across time periods, i.e. lack of longitudinal data, especially for land grant institutions. For this study, data were available on National Science Foundation across 1993, 1994, 1997, 1998, 2003, 2005. While data were readily available from NSF, BLS, USTPO and the Census Bureau, there were various problems. First, NSF data are crude for they are readily available for state level only for most variables and facilitate the study to establish a relationship between the dependent variable and other SandT indicators. Moreover, strategic SandT planning in the US is conducted at the state level and so have economic geographers researching innovations relied upon the NSF datasets in most cases (Calzonetti et al 1999; Calzonetti and Gatrell 2000; Ceh 2001; Gatrell and Ceh 2003; Feldman and Florida 1994; Mitchelson 1999). Thus, NSF datasets with state-level data does not permit exploration of analysis at other scales besides the state scale and also on the non-traditional scales such as metropolitan region or the firms (Cox 1996, 1997, 1998; Jaffe 1994, 2000). While some variables existed for certain years, others existed for other sets of years. This problem was resolved by pooling the data over time. Where the data existed, at times the names have been changed, and it was difficult to assess if these variables meant same across time periods.

Data availability was a major issue, especially at the scale of land grant institutions, wherein consistency over time period was missing. As a result, only two variables were available over the study period, and these have been used at the LGI scale of analysis. While some of these deficiencies have been compensated by using various socio-economic and demographic characteristics from the US Census and the Bureau of Labor Statistics, any measures to obtain and maintain a greater variety of economic data over a longitudinal period of time will be a worthwhile venture. This will enhance the quality of research, along with possibilities for making policy recommendations.

CHAPTER 6

SPATIALIZED POLICY IMPLICATIONS: EPSCoR STATES

The economic restructuring of 1980s and 1990s has dramatically changed the spatial structure of regions within the US, as has been evidenced with the emergence of knowledge regions, such as Silicon Valley in California, Route 128 near Boston, Massachusetts, and the Research Triangle Park in North Carolina (Ceh and Gatrell 2006; Gatrell 1999). In the process of restructuring, some regions seized the opportunity for economic development, while many other remained underdeveloped and peripheral in nature. The aspiration of both, developed and peripheral regions to grow as a knowledge region often forces them to enter into new alliances, institutional arrangements, and policies requiring spatial division of labor, and exacerbating current spatial inequalities.

The current study is witness to such processes and policy implications. It is in this context that the emergence of spatialized public policy programs such as EPSCoR can be appreciated. Originally, designed to enhance the ability of eligible states and jurisdictions, EPSCoR evolved over time both in its objectives, missions, functions and expectations. Nearly, more than twenty-five years after the program jumpstarted, EPSCoR states still need sheltered growth and development to enhance its science and technology capabilities, and to remain competitive.

Several independent evaluations commissioned by the National Science Foundation have unanimously claimed weak evidence at best that the EPSCoR states are any more competitive in their SandT capabilities today than they were twenty years ago. Based upon the current study of different SandT indicators, and related variables over the period of 1995-2005, it is obvious that the EPSCoR states grew at just slightly above the national average. Considering the fact that the birth of EPSCoR itself was based upon the geography of science and technology inequality among states, it became obvious for the congress and its legislatures and policy makers to continue to build a strategy that took its inspiration from regional success stories, such as Silicon Valley and Route 128. The experience of both, Silicon Valley and Route 128 like that of EPSCoR was based upon the idea of a kick start by federal government funding of research universities, as has happened to Stanford and MIT (Saxenian 1994 and 1998). While both Stanford and MIT became embedded in their local and regional economic development processes, often working with institutional aggressiveness, creating spinning off organizations, and working in close partnership with the federal government, in the process advancing and sustaining their own economic development goals and research agendas.

The obvious lesson learned from the experience of Silicon Valley and Route 128 is how these regions did not grow by simply borrowing federal dollars, but also simultaneously capitalizing on available regional assets. Some EPSCoR states, such as West Virginia, which entered the EPSCoR program in 1980, though not a star performer, has been working to transition from a mass production region to a knowledge region (Calzonetti and Gatrell 2000). Arguably, then, strategic science and technology planning as a development instrument should not only rely on equity of dollar distribution, or on performance measurement of number of PhDs granted, patents awarded, venture capital disbursed, but also on the growth of capacity and competitiveness.

Based upon this study, and findings from Chapter 3, it may be noted that EPSCoR states are becoming increasingly sophisticated in their strategic science and technology-based planning efforts, and in recent years, these policy efforts have led directly into the state's industrial policy. In many cases, EPSCoR states' strategies are epitomizing the experience of leading states, such as Washington, Nevada, Florida, Texas, California, and Michigan. As observed in the discussions in Section 5.8, there is a direct relationship between academic RandD and the numbers of doctorates, patents awarded, and venture capital disbursed. Findings also suggest that wherever the EPSCoR states have epitomized the Non-EPSCoR states in terms of enhanced allocation, RandD allocation as share of gross domestic product, this has resulted in more SandE doctorates conferred, patents awarded, and venture capital disbursed.

The policy implications of these findings is that most EPSCoR states require continued competitive dollar support before they attain the capacity for sustaining independent economic development. In so much, policy strategies for fostering science and technology-based economic development need continued support by congress and also to close the gap in the current patterns of uneven geography as a result of inequities in SandT enterprise.

CHAPTER 7

CONCLUSIONS

7.1 Summary

This dissertation examined spatial distribution of Science and Technology indicators across states and land grant institutions, and how their uneven distribution complicates strategic science and technology planning. Using the example of geographically targeted science and technology initiatives such as the EPSCoR, this empirical study displays the significance of spatialized public policy outcomes for economic development of peripheral regions. This study has used data from the National Science Foundation, Bureau of labor Statistics, and US Census to analyze metrics of science and technology, particularly the gaps if any between input SandT metrics (expenditure) and output SandT metrics (patents, phds, etc). Using a three-step approach namely, ranking of indicators, correlation and regression, and shift-share analysis to explain the spatial patterns of science and technology indicators at two scales namely states and land grant institutions.

The significance of these methods lies in the fact that they allow cross verification of findings to establish benchmarks for spatial distribution of science and technology indicators. Results obtained from both regression modeling and shift-share analysis confirms the two hypotheses in a descriptive and exploratory fashion, though it does not outline the causes of unevenness in the distribution of science and technology indicators which is beyond the scope of this study.

The significance of this study is that it uses multiple statistical methods to establish that the development of any state as a technology-based economy is dependent on a number of factors, such as a sophisticated and professionally qualified workforce, the availability of research and development industries, local sources of capital, and availability of strong and collaborative research universities which have all become springboards of science and technology-based development.

The principal conclusion of this study is in the form of a hypothesis proved that (i) EPSCoR program has made little difference in bringing about technology-based economic development in EPSCoR states as measured by key indicators, and (ii) the gap between EPSCoR and Non-EPSCoR states has continued to widen resulting in a more uneven geography. The findings of this study both in a historical examination of the development of EPSCoR states and an empirical study through the use of ranking, correlation, regression, and shift-share analyses demonstrate that the distribution of science and technology indicators follows an uneven geography.

This research also manifests that there is a diminished return over time on investments made on academic RandD. The observation is based on the performance of the time variable across all regression models. This is an important finding as it applies to both scales, all-states as well as land grant institutions, thus, partially masking the issue of scale in a study focusing on SandT indicators. The diminishing influence is stronger in Non-EPSCOR states, whereas EPSCoR states mirror the overall patterns as in all states.

The study also suggests the similarities exhibited about such diminishing returns over time, which is faster in Non-EPSCoR states compared to overall sample.

The study further emphasizes the fact that the share of graduates and professionally qualified population, and those employed gainfully have a direct and positive influence on the economic development and performance of the state. These findings demonstrate that the competitiveness and productivity of graduates and professionals across scales, states as well as land grant institutions, as also for EPSCoR and Non-EPSCoR states holds true. One can draw parallels between the predictor PropGradProf which is positive, and its contribution in the services sector as has been observed in shift-share analysis. More importantly, this shows the real world consequences of economic restructuring-deindustrialization, reindustrialization, and the information age signaling the growth of the service sector and the creative class. The current research findings have been affirmed by past scholarly works also (Florida 2002; Gatrell 1999, 2002). Similar trends have also been observed in the case of academic article output, which in a sense is counterintuitive since it is expected that an increase in published research and citations have a positive impact on the growth of academic RandD.

Another important contribution of this study is in the realm of spatialized public policy implications. *First*, it is confirmed that EPSCoR states trying to build its science and technology capabilities requires strategic focus on the traditional competitive advantage of a region before it wishes to make the transition into a knowledge region. *Second*, states are likely to specialize in different submarkets of SandT enterprise-based upon their place-specific competitiveness and resource endowments.

This study contributes to the literature of regional economic development and public policy by engaging in the process of empirical mapping and measurement of science and technology indicators. As such, it fills in a major gap in economic geography by expanding upon the limited library of geographic research on science and technology indicators.

7.2 Suggestions for Future Research

Based upon this dissertation research on the uneven geography of science and technology indicators, several questions emerge which suggest prospective research trajectories.

First, the observed difference in the geography of science and technology indicators confirmed the gap between EPSCoR and non-EPSCoR states at the scale of states. It remains to be investigated whether these results may hold good for other scales such as metropolitan statistical areas (MSAs), counties, and other non-traditional scales such as firms, universities, etc.

Second, emerging from above is the perennial issue of availability of data at (i) finer and varied scales of geography, (ii) longitudinal scales, and (iii) consistency and compatible measures.

Third, methodologically and empirically there is further need to conduct studies for analyzing micro-scalar variations, which may employ Local Moran's I, econometric measures, Theil Entropy Decomposition methods for analyzing inequality, etc.

The fact that science and technology indicators are under researched by economic geographers, and the notion that several science and technology indicators in this research have performed counter-intuitively, calls for continued research that addresses and investigates the uneven geography of science and technology indicators.

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APPENDIX A: Pooled Raw Data

States	AAO	ARandD	ADVSandE	AVGUG	BWF	SandEHD	SandEGRAD	TimeD
Alabama9394	6.35	3.45	21.30	5,295	20.60	25.10	9.14	1
Alaska9394	2.52	2.91	28.40	5,978	26.60	29.10	8.09	1
Arizona9394	7.24	3.65	27.00	5,463	31.70	26.90	10.93	1
Arkansas9394	7.51	1.70	15.70	5,296	21.40	22.50	5.86	1
California9394	7.56	2.93	25.40	7,524	35.40	37.10	9.61	1
Colorado9394	7.11	3.63	25.00	6,190	35.80	38.40	15.15	1
Connecticut9394	7.47	3.46	23.80	7,915	36.60	31.30	11.99	1
Delaware9394	10.07	2.28	20.30	7,790	29.60	35.30	12.77	1
D. of Columbia9394	8.17	3.32	41.10	NA	47.40	40.50	76.73	1
Florida9394	8.49	1.63	23.00	5,861	29.80	25.30	6.86	1
Georgia9394	5.27	3.30	22.80	5,063	27.00	26.60	7.25	1
Hawaii9394	7.91	2.06	25.00	1,452	34.60	29.90	9.23	1
Idaho9394	6.10	2.22	25.30	4,977	23.80	27.70	9.92	1
Illinois9394	9.37	2.45	28.00	6,999	30.10	26.90	11.72	1
Indiana9394	10.16	2.33	20.10	6,640	18.20	29.90	10.50	1
Iowa9394	7.67	4.78	17.80	5,439	22.00	28.20	12.49	1
Kansas9394	8.07	2.67	20.10	5,137	30.50	26.00	12.78	1
Kentucky9394	10.70	1.59	18.70	5,027	24.30	23.40	6.24	1
Louisiana9394	7.00	2.83	21.00	5,214	24.10	25.00	8.21	1
Maine9394	9.85	1.04	8.40	7,503	28.90	32.30	4.17	1
Maryland9394	3.69	5.62	27.80	8,147	33.90	35.10	10.34	1
Massachusetts9394	7.79	6.47	28.10	8,503	40.30	32.30	18.83	1
Michigan9394	6.99	3.19	23.20	7,668	25.50	29.00	10.67	1
Minnesota9394	7.50	2.93	15.90	5,929	27.90	28.50	9.53	1
Mississippi9394	4.79	2.38	21.00	5,088	24.10	24.90	6.91	1
Missouri9394	8.55	2.97	23.90	5,833	26.00	24.20	7.79	1
Montana9394	5.51	3.13	17.90	5,668	28.00	30.80	12.12	1
Nebraska9394	7.78	3.51	19.80	4,925	22.30	23.60	11.95	1
Nevada9394	4.74	1.98	23.10	6,379	21.80	23.30	5.82	1
New Hampshire9394	6.17	3.60	14.40	7,801	34.60	30.10	5.97	1
New Jersey9394	7.54	1.54	25.80	8,251	39.00	35.00	8.75	1
New Mexico9394	3.93	5.12	31.40	5,062	30.70	31.60	14.81	1
New York9394	8.23	2.91	26.00	7,721	35.20	29.70	13.99	1
North Carolina9394	7.59	3.79	16.30	4,706	24.00	32.60	8.20	1
North Dakota9394	5.18	4.20	14.10	5,253	26.10	25.70	9.88	1
Ohio9394	8.79	2.31	26.40	6,992	27.00	27.40	11.29	1
Oklahoma9394	5.15	2.69	27.00	4,027	28.50	24.80	9.16	1
Oregon9394	6.97	3.29	20.90	6,630	31.00	33.40	9.56	1
Pennsylvania9394	7.64	3.61	21.00	8,277	27.70	29.80	11.13	1
Rhode Island9394	8.45	4.37	20.00	8,604	28.40	26.10	12.39	1
South Carolina9394	6.38	2.46	16.70	6,206	22.00	27.70	6.67	1

APPENDIX A (Continued)

States	AAO	ARandD	ADVSandE	AVGUG	BWF	SandEHD	SandEGRAD	TimeD
South Dakota9394	6.31	1.41	16.80	4,917	25.00	31.30	9.46	1
Tennessee9394	7.50	2.35	17.70	5,019	20.20	27.50	8.12	1
Texas9394	6.20	3.17	25.30	4,934	28.00	28.00	9.99	1
Utah9394	7.74	5.07	19.00	5,125	23.50	33.50	14.50	1
Vermont9394	7.88	3.87	15.40	10,054	30.80	36.60	7.61	1
Virginia9394	7.53	2.42	19.20	7,725	32.40	36.00	9.97	1
Washington9394	6.99	3.13	22.00	6,476	36.30	30.90	7.12	1
West Virginia9394	7.19	1.71	15.70	5,687	20.20	21.30	8.91	1
Wisconsin9394	7.33	3.79	17.00	5,249	23.80	30.40	11.21	1
Wyoming9394	6.70	2.34	25.90	4,900	22.80	36.60	13.98	1
Puerto Rico9394	NA	1.30	11.30	NA	NA	24.20	NA	1
Alabama9899	4.26	4.16	21.9	6,558	29.5	25.3	8.24	2
Alaska9899	2.10	3.29	32.9	8,403	32.0	35.2	9.19	2
Arizona9899	5.10	2.96	27.7	6,985	30.4	22.0	10.01	2
Arkansas9899	5.11	1.90	15.9	6,172	23.0	24.4	6.15	2
California9899	5.25	3.12	24.1	9,035	35.9	38.3	9.92	2
Colorado9899	5.24	3.41	25.7	7,840	44.4	39.4	15.76	2
Connecticut9899	7.19	2.80	25.6	9,902	43.5	32.5	12.59	2
Delaware9899	7.13	1.97	20.8	9,515	30.7	30.2	12.53	2
D. of Columbia9899	5.41	4.50	45.7	NA	52.1	41.2	71.79	2
Florida9899	6.03	1.71	22.4	7,283	29.2	26.1	7.21	2
Georgia9899	4.04	3.15	22.1	7,457	26.5	28.1	6.99	2
Hawaii9899	3.78	3.93	26.2	8,182	34.5	32.9	10.17	2
Idaho9899	3.91	2.42	20.7	6,321	25.0	29.0	9.73	2
Illinois9899	6.66	2.43	29.2	8,812	31.6	27.2	12.52	2
Indiana9899	7.32	2.39	22.0	8,584	22.7	28.7	9.48	2
Iowa9899	6.43	4.28	18.9	6,762	25.2	29.4	11.88	2
Kansas9899	5.49	2.79	22.9	6,236	32.6	26.6	16.19	2
Kentucky9899	5.43	2.20	19.0	6,222	27.0	25.0	6.27	2
Louisiana9899	5.34	2.98	21.7	5,919	28.9	28.1	8.80	2
Maine9899	7.34	1.10	9.8	8,926	31.0	33.5	3.46	2
Maryland9899	5.13	5.49	29.1	10,512	45.0	35.8	11.61	2
Massachusetts9899	6.84	5.69	29.6	9,099	38.6	32.9	20.02	2
Michigan9899	5.51	2.86	25.9	9,205	26.8	29.3	10.34	2
Minnesota9899	6.54	2.21	17.9	7,561	35.5	30.1	10.30	2
Mississippi9899	4.20	2.53	19.7	6,015	26.9	24.0	7.73	2
Missouri9899	6.52	2.97	26.2	7,728	29.1	26.5	7.68	2
Montana9899	4.08	3.86	18.3	7,054	30.4	35.4	12.84	2
Nebraska9899	5.62	3.57	19.5	6,482	23.4	24.0	10.65	2
Nevada9899	4.54	1.31	24.9	7,596	24.3	27.2	5.82	2
New Hampshire9899	5.29	3.01	13.4	10,532	31.8	31.9	6.29	2

APPENDIX A (Continued)

States	AAO	ARandD	ADVSandE	AVGUG	BWF	SandEHD	SandEGRAD	TimeD
New Jersey9899	6.09	1.55	22.5	10,977	39.2	37.3	9.07	2
New Mexico9899	3.37	4.98	30.0	6,433	33.8	30.0	13.66	2
New York9899	6.53	2.81	25.2	9,698	37.0	29.2	14.31	2
North Carolina9899	5.55	3.71	16.8	6,525	29.9	33.7	8.70	2
North Dakota9899	4.79	3.27	14.8	6,615	26.5	28.4	11.85	2
Ohio9899	6.34	2.32	26.9	9,428	33.4	28.2	10.44	2
Oklahoma9899	4.40	2.62	30.6	5,740	32.3	26.6	9.04	2
Oregon9899	5.02	3.11	20.6	8,755	34.5	34.7	8.39	2
Pennsylvania9899	6.08	3.72	21.0	10,085	32.5	30.2	11.33	2
Rhode Island9899	7.49	3.79	19.7	10,284	33.9	27.9	10.32	2
South Carolina9899	4.94	2.40	17.3	7,989	28.6	29.1	5.90	2
South Dakota9899	5.54	1.22	19.3	6,264	28.1	35.8	9.47	2
Tennessee9899	6.66	2.16	18.3	6,386	23.0	27.6	7.48	2
Texas9899	5.14	2.70	26.8	6,756	30.4	28.3	9.43	2
Utah9899	6.38	4.13	15.3	6,196	29.2	33.1	12.78	2
Vermont9899	6.32	3.69	20.6	12,238	34.4	36.8	7.20	2
Virginia9899	6.28	2.18	20.9	8,980	40.2	35.1	10.47	2
Washington9899	5.87	2.78	18.0	7,985	36.6	31.4	7.25	2
West Virginia9899	6.46	1.60	19.3	6,755	28.2	23.5	9.41	2
Wisconsin9899	5.98	3.34	16.6	6,730	27.5	29.6	10.41	2
Wyoming9899	4.06	3.24	29.0	6,830	27.4	42.0	14.83	2
Puerto Rico9899	2.19	1.62	12.1	NA	NA	28.0	NA	2
Alabama0405	3.38	3.90	28.6	8,983	31.80	24.90	10.50	3
Alaska0405	1.59	3.90	34.9	10,118	32.20	32.10	8.40	3
Arizona0405	3.42	3.39	16.9	10,140	37.30	18.20	7.90	3
Arkansas0405	3.54	2.41	16.9	8,349	26.90	23.10	6.50	3
California0405	3.32	3.88	24.9	12,275	42.60	38.30	12.10	3
Colorado0405	3.45	3.85	24.2	9,751	42.60	37.30	12.50	3
Connecticut0405	4.70	3.46	27.1	12,772	45.50	30.90	16.80	3
Delaware0405	5.50	2.04	23.5	12,496	35.50	28.90	16.30	3
D.of Columbia0405	4.18	3.67	44.4	NA	65.90	40.80	83.10	3
Florida0405	3.74	2.17	21.9	9,207	37.40	28.30	8.60	3
Georgia0405	3.29	3.56	22.1	9,090	36.40	29.60	7.90	3
Hawaii0405	2.58	4.39	22.9	8,760	36.80	33.40	10.80	3
Idaho0405	2.89	2.61	18.0	8,091	30.30	26.30	9.80	3
Illinois0405	4.39	3.19	31.9	11,804	36.90	27.10	13.00	3
Indiana0405	4.69	3.21	21.3	11,637	28.20	27.20	11.50	3
Iowa0405	4.38	4.66	17.2	10,878	30.20	28.90	14.00	3
Kansas0405	3.90	3.31	22.7	8,604	37.20	26.90	16.60	3
Kentucky0405	3.63	3.26	25.5	8,521	30.90	24.20	8.00	3
Louisiana0405	3.56	3.21	22.6	7,494	31.90	27.40	8.10	3

APPENDIX A (Continued)

States	AAO	ARandD	ADVSandE	AVGUG	BWF	SandEHD	SandEGRAD	TimeD
Maine0405	3.70	1.82	7.7	11,010	31.90	31.20	4.50	3
Maryland0405	3.28	6.87	29.6	13,419	46.00	39.10	15.40	3
Massachusetts0405	5.14	6.50	30.3	12,250	49.50	33.40	26.80	3
Michigan0405	4.01	3.91	27.0	12,208	33.30	28.40	11.80	3
Minnesota0405	4.79	2.42	19.1	10,845	38.60	27.40	15.90	3
Mississippi0405	2.39	4.43	22.2	8,547	28.80	22.50	8.20	3
Missouri0405	3.88	4.15	26.9	10,320	36.30	24.60	9.60	3
Montana0405	2.22	5.71	19.8	9,348	34.40	35.10	12.50	3
Nebraska0405	3.24	4.99	21.1	9,620	28.90	23.40	12.50	3
Nevada0405	2.99	1.62	26.4	10,333	31.90	27.20	5.50	3
New Hampshire0405	2.70	5.31	14.8	13,852	42.10	30.80	9.40	3
New Jersey0405	3.95	2.03	24.3	15,109	46.90	34.40	10.90	3
New Mexico0405	2.43	4.96	30.0	8,238	34.40	29.40	15.10	3
New York0405	3.78	3.75	26.8	12,002	43.40	29.20	16.40	3
North Carolina0405	3.68	4.71	19.1	8,805	30.90	32.00	9.90	3
North Dakota0405	2.41	6.02	15.2	8,028	30.40	23.80	20.30	3
Ohio0405	3.66	3.46	25.2	13,319	32.80	25.80	12.90	3
Oklahoma0405	3.54	2.40	25.8	7,901	30.50	26.30	9.10	3
Oregon0405	3.58	3.78	20.1	11,626	36.60	33.80	8.50	3
Pennsylvania0405	4.07	4.84	21.3	13,754	35.30	29.50	13.80	3
Rhode Island0405	4.71	4.58	16.7	12,763	36.20	29.70	15.00	3
South Carolina0405	3.14	3.47	16.1	12,710	34.40	27.60	5.70	3
South Dakota0405	2.46	2.19	23.4	8,379	28.30	32.40	10.00	3
Tennessee0405	3.81	3.23	18.0	8,936	35.10	24.90	7.80	3
Texas0405	3.46	3.11	27.2	9,202	31.60	28.10	9.60	3
Utah0405	4.44	4.53	16.4	7,865	34.90	33.30	12.50	3
Vermont0405	3.62	5.09	20.1	14,766	41.70	38.10	9.10	3
Virginia0405	3.84	2.61	22.4	10,900	43.80	34.60	11.90	3
Washington0405	4.10	3.32	17.8	11,353	39.70	32.90	7.40	3
West Virginia0405	2.89	2.73	22.4	8,751	25.30	23.50	9.50	3
Wisconsin0405	3.46	4.60	17.0	9,066	31.00	30.20	12.10	3
Wyoming0405	2.60	3.06	26.4	8,485	26.20	34.40	13.60	3
Puerto Rico0405	2.04	1.21	18.1	NA	NA	24.10	6.60	3

APPENDIX B: Raw Data for Land Grant Institutions

LGIs/State	Federally Financed RandD Expenditures at UandC	RandD expenditures at universities and colleges
Arizona_9394	145696	269939
California1_9394	842826	1725791
California2_9394	112502	127946
Colorado_9394	66464	112457
Connecticut_9394	48286	136740
District of Columbia_9394	NA	NA
Florida1_9394	20730	24691
Florida2_9394	79630	148592
Georgia1_9394	2591	2648
Georgia2_9394	55005	187849
Illinois_9394	138734	245407
Indiana_9394	82148	172733
Iowa_9394	56439	155982
Maryland1_9394	1128	1128
Maryland2_9394	86051	198348
Massachusetts1_9394	32730	65344
Massachusetts2_9394	270718	374768
Michigan_9394	73855	163285
Minnesota_9394	181039	317865
Missouri1_9394	2869	3121
Missouri2_9394	2559	6664
New Jersey_9394	68149	173211
New York_9394	193981	312683
North Carolina1_9394	10132	13637
North Carolina2_9394	69608	173407
Ohio_9394	113186	230515
Oregon_9394	65069	119772
Pennsylvania_9394	168679	302997
Texas1_9394	5693	8306
Texas2_9394	136942	355750
Utah_9394	46128	79085
Virginia1_9394	NA	NA
Virginia2_9394	73490	148313
Virginia3_9394	4529	4569
Washington_9394	45691	94819
Wisconsin_9394	225403	392718
Arizona_9899	178126.00	320,245
California1_9899	7673.00	2,490,962
California2_9899	1287284.00	212,216
Colorado_9899	91943.00	150,281
Connecticut_9899	55496.00	134,986

APPENDIX B (Continued)

LGIs/State	Federally Financed RandD Expenditures at UandC	RandD expenditures at universities and colleges
District of Columbia_9899	NA	NA
Florida1_9899	20693.00	21,622
Florida2_9899	122296.00	304,447
Georgia1_9899	2318.00	2,937
Georgia2_9899	56080.00	237,493
Illinois_9899	185767.00	358,247
Indiana_9899	95708.00	226,411
Iowa_9899	54179.00	161,301
Maryland1_9899	2508.00	2,508
Maryland2_9899	145081.00	257,628
Massachusetts1_9899	39877.00	86,576
Massachusetts2_9899	308921.00	420,306
Michigan_9899	89835.00	207,912
Minnesota_9899	207761.00	371,384
Missouri1_9899	2686.00	2,686
Missouri2_9899	4841.00	10,294
New Jersey_9899	75664.00	213,838
New York_9899	234792.00	395,552
North Carolina1_9899	12454.00	14,741
North Carolina2_9899	66310.00	270,621
Ohio_9899	135216.00	322,810
Oregon_9899	81649.00	139,285
Pennsylvania_9899	199105.00	379,402
Texas1_9899	8675.00	10,157
Texas2_9899	149151.00	402,203
Utah_9899	54433.00	95,364
Virginia1_9899	NA	NA
Virginia2_9899	75386.00	169,250
Virginia3_9899	2061.00	NA
Washington_9899	44610.00	96,943
Wisconsin_9899	249961.00	499,688
Wyoming_9899	19109.00	47,197
Puerto Rico_9899	23784.00	55,648
Arizona_0405	292,811	530,233
California1_0405	2,206,006	4,129,493
California2_0405	5,743	265,364
Colorado_0405	154,245	236,211
Connecticut_0405	134,347	219,982
District of Columbia_0405	NA	NA

APPENDIX B (Continued)

LGIs/State	Federally Financed RandD Expenditures at UandC	RandD expenditures at universities and colleges
Florida1_0405	22,378	26,400
Florida2_0405	231,699	530,734
Georgia1_0405	2,492	2,497
Georgia2_0405	102,966	316,806
Illinois_0405	289,985	499,711
Indiana_0405	150,351	364,986
Iowa_0405	98,005	209,545
Maryland1_0405	5,432	NA
Maryland2_0405	196,008	338,648
Massachusetts1_0405	66,921	127,487
Massachusetts2_0405	457,235	580,742
Michigan_0405	156,461	333,735
Minnesota_0405	319,771	548,873
Missouri1_0405	2,093	2,656
Missouri2_0405	84,465	12,056
New Jersey_0405	137,609	309,531
New York_0405	365,694	606,804
North Carolina1_0405	16,348	22,936
North Carolina2_0405	109,128	302,596
Ohio_0405	294,053	608,923
Oregon_0405	109,030	180,309
Pennsylvania_0405	358,569	625,764
Texas1_0405	8,464	11,810
Texas2_0405	212,923	479,735
Utah_0405	92,660	131,624
Virginia1_0405	NA	NA
Virginia2_0405	109,842	5,048
Virginia3_0405	2,668	289,994
Washington_0405	80,222	182,677
Wisconsin_0405	477,582	798,099