The Polycentricity of Innovation:
Explaining variation in the new role of the states in science and technology policy

Derek Kauneckis, Ph.D.
Asst. Professor, Department of Political Science
University of Nevada, Reno
Reno, Nevada 89557
Email: kauneck@unr.edu

Abstract: There have been important shifts in the locus of activity in science and technology (S&T) policy within the American federal system. Traditionally the states have followed a research agenda set at the national level and acted as the implementation organization for federal funds. Today the states have taken on an increasingly proactive role as active partners in collaborative arrangements, provide independent funding for local research priorities, as well as setting their own agendas even counter to those the federal level. While the most high profile cases include stem cell research, alternative energy and climate change mitigation these are indicators of an increasingly autonomous and independent role of the states in directing S&T policy. This paper examines the types of state-level activities, their distribution and provides evidence to explain the variation. It uses a theoretical framework derived from research on public goods production within polycentric systems of governance to explain the various strategies adopted by the states in this new landscape of S&T policy. The paper concludes with implications for redesigning federal S&T support as well as lessons for state governments.

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Introduction

The past two decades has seen a remarkable shift in the locus of public action to spur scientific discovery and technological innovation in the United States. Traditionally public decisions about the direction of investment in the creation of new knowledge in science and technology (S&T) was conducted at the national-level, with funds reallocated to state universities and federal labs, and the role of transferring technology to marketable products left to the private sector. Today, state governments are active in formulating policy, directing significant level of local public investment, and providing a variety of financial and intellectual infrastructure for both basic R&D as well as bringing technological innovation to the market. As summed up in a recent study, "…the federal government is no longer the sole focus of R&D funding and S&T policy making…the states have assumed an increasing responsibility for developing, formalizing, and institutionalizing policy and programs..." (Oslon and Labov 2008: xi). The states have moved from simply implementing federal S&T initiates toward an active role that includes developing independent policy agendas, a high degree of coordination across and within local government units, and even direct substitution for federal inaction in some policy areas. The landscape of science and technology policy has shifted toward the states in fundamental ways.

This paper presents an initial analysis of a new dataset collected over the past year that attempts to document and measure state-level S&T initiatives during the ten year period from 1997-2007. Data was collected on all state-funded S&T activities toward understanding both how the role of the states has changed, as well as the relationship between state and federal government. While there has been broad documentation of the specific programmatic foci (biotechnology and stem cell research being most prominent in the literature), there have been few studies that have examined the entire research portfolio within each state. The study focused on a bottoms-up perspective and looked at the actions of states as independent actors in policy agenda setting. Rather than focusing only on the collaborative activities between the federal and state governments (such as Alder, 2006), it looks at programs initiated by the state themselves. While this necessarily includes activities that occur cooperatively between state and federal governments as well as the private sector, by focusing on those activities fundamentally initiated by the states this project presents a different and important perspective on the evolution of American science and technology policy.

For the purpose of this paper, the term science and technology (S&T) policy is used to refer exclusively to research and development activities that are intended to generate new methods, techniques and technology. This reflected in the data collection methodology used on in this project and to distinguish the types of activity that were excluded. The terms, research and development (R&D) and science and technology (S&T) are often used interchangeably to refer to any number of a broad array of activities. While R&D typically refers to the investment made in bringing research to marketable products, we were more broadly interested in the generation of new ideas, processes and applications of technology and scientific understanding toward problem solving. S&T policies can include a wider array of activities; from applying existing technologies to tackle state problems, technological components of basic education, to standard university capacity building, and even adult technology education. While these are components of state S&T policy, they can be understood as the traditional role of state governments and as reaction to a changing economy and educational demands rather than taking on the function of developing capacity for the production of innovation. The focus of this study is on state investment in the development of innovation infrastructure that can generate new technologies and constitute local knowledge-based economies.

The Evolving Role of the States

Science and technology policy in the United States has passed through a number of important phases that helps explain the current role of the states. Prior to World War II research activity was dominated by a small number of federally funded labs focused on basic R&D and collaboration with the private sector toward developing commercial applications. Federal government involvement increased when President Roosevelt established the National Defense Research Council (NDRC) in 1940 in anticipation of US involvement in the Second World War. Most of this research was conducted directly within the University system for military development. The intellectual impetus for federal funding of non-military applications of S&T came with the 1945 report *Science-The Endless Frontier* by Vannevar Bush highlighting the inadequacy of the private sector to conduct basic science research and the need for government investment in R&D as a fundamental public good. Despite initial congressional resistance the National Science Foundation (NSF) was established in 1950 and competition with the Soviet Union and the beginning of the cold war lead to the creation of the President's Science Advisory Council (PSAC) in 1951. Throughout the 1960's there was consistent federal support for S&T typically channeled through state University systems.

The 1970's saw some reversal in this trend due to public mistrust of government due to the involvement in Vietnam and broad societal concern over the negative impact of technology exemplified by the environmental movement. The nature of the definition of what public problems government was responsible for addressing had also changed, and there was increased attention paid to social problems such as poverty and civil rights and the PSAC, dominated by physical scientists, was unable to provide the knowledge required for President Johnson's Great Society initiatives. By 1973 President Nixon had eliminated the PSAC and position of presidential science advisor. An Executive role in S&T policy was reinstituted with the creation of the Office of Science and Technology Policy (OSTP) under Ford in 1974 and continues today.

A major impetus for state-level research policy began with the 1980 Bayh-Dole Act that permitted intellectual property rights from research conducted within the university to be assigned to the university itself. This vested state-level financial interest in the generation of new knowledge and applications of science and technology. It spurred the creation of university technology transfer programs and strengthened the link between university research and product development and highlighted the role of universities in regional economic development (Storper 1995; Rosenbloom 2007). State activity was further encouraged with the 1979 NSF Experimental Program to Stimulate Competitive Research (EPSCoR), which assisted in the development of state research capacity. The 1980's can generally be thought of as a period of expanding state capacity. The 1990's continued this development, and the rise of the digital economy illustrated the real fiscal payoffs to investment in knowledge-based industries. During this period the states became much more proactive in developing and attracting local S&T capacity. The period has been broadly characterized as one collaboration between federal and state research organizations (Alder 2006). While specific regions reaped the lion's share of the benefits from the digital economy, it sparked a flurry of state activities to attract and retained high technology industries. This created new local political constituencies as well as reinforced existing ones.

With the election of President Bush there were significant shifts in the role of the states. While federal funding in many areas of S&T research continued and even increased from 2000 to 2007, there were two important divergences. The first was regarding climate change science and associated policy. The Bush Administration's initial reluctance to accept the underlying science, and continued hesitation to formulate an effective policy response alienated many in the scientific community. Regions with significant environmental constituencies and already utilizing low emission power sources such as natural gas rather than coal demanded more robust action than the voluntary reduction programs offered by the administration. Eleven state attorneys general wrote to Pres. Bush requesting an expanded national effort to reduce emissions (Rabe 2002). In response to federal inaction, the states generated a remarkable set of greenhouse gas policy innovations as documented by Rabe (2002). Some of the activity at the state level involved direct regulatory action, such as Govt. Gray Davis of California's 2002 legislation to set standard for CO_2 emissions from motor vehicles. However, state action extended well beyond regulatory policy and into research on renewable energy, transportation and waste management.

The second significant shift from the federal policy agenda was that in the area of stem cell research. President Bush's limited ban on the use of federal funds in 2001 for research involving stem cell presented an opportunity for state politicians to distinguish themselves for the sake of political symbolism, as well as offering a opportunity for stem cell research-friendly states to attract biotechnology industries. Following federal restrictions a number of states passed legislation both in support of, and opposition to federal policies. In 2004 California voters approved a $3 billion ballet initiative for the support of embryonic stem cell research through the California Institute for Regenerative Medicine. New Jersey had earlier already passed legislation in support of $6.5 million to recruit researchers for the state's Stem Cell Institute.

Both climate change and stem cell research represent situations where some state action was in direct opposition to that of federal policy. In some cases state-level policy was intended to symbolically support federal action, while in others it presented a strategic opportunity to highlight state willingness to move away from the federal research agenda and support such research and the potential benefits from industrial relocation and product development. The early period of collaboration between state and federal efforts had changed to something much more dynamic where states variously act in cooperation, coordination and occasionally direct opposition to federal agendas. With the Obama administration there has been a dramatic return of federal support for S&T, however the states continue to act as independent political actors in setting their own research agendas, directly funding research (albeit at significantly lower levels), and providing supportive legislation for knowledge production. Changes in state-level capacity and attitudes have remained and the role of the states in relationship to the federal government are likely entering a new period.

Towards a Theory State Innovation Policy

The literature on S&T policy is dominated by work focusing on the impact of federal programs, state competition, and the impact of S&T investment on regional economic development (see for example Audretsch and Feldman 1996; Alder 2006; SSTI 2006; The State Science and Technology Institute 2006). This focus has most recently been consolidated under the nomenclature of technology-based economic development (TBED). This project examines state S&T portfolios as part of a broader political economy driven not only by the potential economic development, but also secondary benefits including the development of local capacity for addressing complex technical and scientific policy problems, as well as political demands by local constituencies.

Work on state government policy is only beginning to examine the strategic incentives to pursue various types of activities and rationales for local R&D investment beyond supporting and/or attracting industry. States have a variety of reasons for providing support for S&T capacity. While economic development drives much of the justification for the use of public resources for S&T, the types of activities supported by science and technology innovation are quite diffuse. States have policy problems at the local level that can demand significant investment in scientific research that is problem specific. High quality scientific information can inform a range of state policy issues in environmental, health, energy and industrial policy. The application and adoption of technologies for addressing local policy problems can lead to more effective solutions as well as other potential commercial applications. Additionally, the demands from local constituents can be at odds with those of federal policy, and there may be electoral gains from pursuing research that the federal government does not. The most obvious examples are recent state-level initiatives on stem-cell research and climate change. While the rhetorical justification for state S&T funding typically revolves around jobs and the economy, the integration of knowledge generated from state S&T capacity spans a wide variety of policy applications (Pew Center on the States 2007; Olson and Labov 2008).

While an extensive literature exists on the impact of both direct and indirect financial support (Cozzens and Melkers 1997; Melkers and Cozzens 1997; Smilor, O'Donnell et al. 2007) very little work has examined portfolio choice in S&T policy across states. While states continue to compete over the location of industries in the new economy, the requirements of these new types of industries are significantly different from the labor intensive manufacturing industries of the past. Knowledge-based economies generally rely on clustered infrastructures that include access to higher education research facilities, available venture capital, and social networks that share knowledge and reinforce innovation (Etzkowitz 1997; DeVol and Charuworn 2008; Olson and Labov 2008). In order to attract such industries states can no long rely on low competitive wages or simple tax advantages, but rather need a broader array of research and education infrastructure, items traditionally considered public goods.   The role of government activity has become more central to state competition in the new economy.

While the states have different interests in developing state-level capacity, there are a number of characteristics of successful knowledge-based economies. The factors leading to successful centers of research innovation include committed local leadership, presence of financial resources and investment capital, tolerant local culture, relocation of pivotal corporations and organizational capacity (Smilor, O'Donnell et al. 2007). Each of these has an extensive research literature and associated state programs to develop capacity in one area or another, such as the creation of entrepreneurship programs on university campuses to develop local leadership and management skills (Kayne 1999), and “Angel” capital funds to provide venture capital, often under state leadership and even direct state financial support (Lipper and Sommer 2002).

The approach adopted here recognizes that state S&T policy exists in a system of co-production with private and other state-level organization. Co-production is the idea that the creation and generation of public goods can occur by any number of different organizations (Ostrom 1996; McGinnis 1999). Private organizations can generate public goods through economic growth and development and private donations often fund public universities and research centers. Similarly, public funding can occasionally be used to support private activities such as providing venture capital for a local innovation economy where private funding may be lacking. The idea behind co-production is that the simple categories of public and private fail to capture the full complexity of good production and delivery in modern political economies and whether direct state action will produce the desired results will depend on the local situation. The implication for this study is that the use of state resources will be strategic, and the relationship to state capacity will vary depending on the relative position of the state to the national and regional situation, rather than being a simple linear association. States may use resources to signal new areas of interest in emerging technologies or supplement activities where private action is lacking.

State decisions on what S&T activities to pursue will be based strategically on the existing array of programs, the current capacity of a state, attempts to build future state capacity, compelling state-level problems that require basic scientific research, and local political constituencies that value scientific inquiry. Based on the existing literature a set of preliminary theoretical hypotheses can be generated. First, there are two potential paths of diversification and specialization that can be expected in the broad portfolios of states. As state capacity increases one can expect to see both an increased scope and depth of S&T activities. In other words, states with the greatest capacity will tend to be associated with more diverse and larger portfolios as they build on existing strengths and expand. There is clear evidence that stronger states compete much more effectively for federal research funds. In a recent NSF report it was found that only six states account for over half of the total state-level S&T funding (National Science Foundation - Division of Science Resources Statistics 2008).[1] An alternative hypothesis is that it is precisely the least competitive states that have the most diverse S&T portfolios. High capacity states are able to remain focused and specialize in specific activities over which

[1] These included Pennsylvania, California, New York, Michigan, Ohio, and Florida.

they maintain a competitive advantage. Lower capacity states are essentially trying to fish for knowledge-based industries and develop very diverse portfolios in the hope of landing at least one. Figure 1 presents some of the empirical evidence testing these hypotheses.

A second question is over the speculative verses applied value of S&T projects. Many of the newest technologies, including nanotechnology and stem cell research, present at best potential future applications and products rather than directly addressing societal problems. Other areas of research, such as applied health and environmental technologies, can be directly applied to so solving local policy issues and concerns of the public. The preliminary hypotheses parallel those presented above. It is possible that high capacity states are best suited to develop applied research programs as a spillover component of more speculative programs. One of the standard justifications for investment in S&T capacity is to develop the local scientific expertise to tackle complex policy problems. An alternative hypothesis is that low capacity states simply do not have the infrastructure to compete, so allocate resources toward projects that directly address local concerns. Public investments become more politically palatable and serve as seed programs on which future infrastructure can be built.

The Study

This project was designed to measure state-level activities in S&T policy from 1997-2007. The data collected for this study documented over 460 programmatic activities by the states that included direct allocation of public resources. These included any activity dedicated to new processes or technology. Since states have different resources and expend these strategically toward developing, attracting or retaining local knowledge-based industries inclusion of programs attempted to be as broad as possible. Activities coded as spending toward S&T included legislative activity that directed funding towards specific activities, the creation of state-supported research centers dedicated specifically to S&T, and a variety of product development, entrepreneurship centers and state-supported venture capital funds. Each programmatic activity was coded according to the type of activity undertaken (nanotechnology, aerospace, health, environmental, etc.), and the types of state support (creation of a research center such as California Institute for Regenerative Medicine or New Jersey's Stem Cell Institute, venture capital fund, direct research support, etc.).

The collection of information on state-level S&T policy programs is challenging since activities can be quite diverse and occur through any number state agencies and programs. While there has been important research conducted on S&T programs channeled through University systems, significant activity can occur through traditional economic development agencies, the creation of new organization dedicated to coordinating S&T programs (New York's NYStar is an example), and various public/private partnerships. The focus on a single avenue of funding misses many important activities, especially among lower capacity states. The data for the dependent variables used here were derived from three primary sources. The first was coding of all *State Science and Technology Institute* (SSTI) reports. These were issued starting 1997 and are offered as a means of sharing information on state legislative and programmatic among S&T professionals. The second source was through direct contact with state economic development and/or S&T agencies where they exists. Direct verbal confirmation of each program was possible, as well as program inception dates, levels of funding, funding source, and other information. State agencies were able to direct researchers to the third source of information - annual report, state summaries, legislative budgets and other grey literature and government documents. All entries were compiled in a database and coded according to a common coding rubric.

In addition to recording the programmatic activity of each initiative, two measures of a state's S&T portfolio for the period from 1997-2007 were created. The first is a simple count of the number of programs in each state (*Count*). It provides a rough measure of the size of S&T activities. A second measure was that of the diversity of the portfolio of programs (*PortDiv*) created during that same period. For this an index of the number of programs weighted by the number of activities within each separate program was calculated.

In order to examine the presence and absence of specific S&T programs three variables indicating the type of research activity were generated. The more speculative S&T programs were measured by the creation of nanotechnology programs (*Nanotech*) during the study period.[2] The presence of applied S&T programs was measured by any activity in the areas of agricultural technology, food processing, transportation, environmental quality or health. The categories capture the types of activities of concern to local industries (for example, Oregon directly funds seafood packaging research) and public policy issues important to constituents (Idaho's Center for Research on Invasive Species). Finally, health programs (*health*) were isolated as a research concern of broad public interest to avoid a focus on only very localized problems and better understand how states respond to more universal demands for science outputs. Descriptive statistics for each measure of programmatic activity are presented below in Table 1.

[2] Arguably stem cell research represents an equally or even more speculative activity, however programs were often subsumed within broader biotechnology programs and are more difficult to disaggregate. Nanotechnology programs tended to be more directly discernable from other activities.

Table 1: Descriptive Statistics

Variable	Type	Mean/ Median	Min	Max	Std. Dev.	Description
PortDiv	Continuous	0.56	0	2.5	0.5	Weighted average of diversity of state S&T portfolio
Count	Count	9.16	0	53	9.7	Total count of state S&T programs
Nanotech	Binary	0.3 / 0	0	1	0.5	Funding of nanotechnology R&D program from 1997-2007
Applied	Binary	0.7 / 1	0	1	0.5	Funding of applied R&D program from 1997-2007
Health	Binary	0.6 / 1	0	1	0.5	Funding of health-related R&D program from 1997-2007
HumCap	Continuous	52.3	23.8	78.2	14.6	Human capital investment index [1]
R&D Inputs	Continuous	51.2	18.5	93.1	18.1	Research and development inputs index [1]
RiskCap	Continuous	54.6	21.7	81.3	13.5	Risk Capital and Entrepreneurial Infrastructure Index [1]
Work Force	Continuous	56.4	18.5	91.1	17.0	Technology and science work force index [1]
TechCon	Continuous	54.1	26	85.4	16.0	Technology concentration and dynamism index [1]
HighEd '98	Continuous	9.9	0.6	63.2	10.8	Higher education expenditures in 1998 ($ 00,000,000) [2]
10yr Chg	Continuous	0.5	0.1	1.2	0.3	% change in higher education spending from 1998-2008 [2]

[1] Data Source: DeVol, R. and A. Charuworn (2008). *State Technology and Science Index: Enduring Lessons for the Intangible Economy*. Santa Monica, Milken Institute.

[2] Data Source: Grapevine (2008). *An Annual Compilation of Data on State Tax Appropriations for the General Operation of Higher Education, 50-State Summary*.

The independent variables used in this analysis were derived from a number of existing secondary data sources. Most of these were from the Milken Institute's *State Technology and Science Index* (2008) which has developed a composite index of state capacity for each of the fifty states. Each index measures a variety of variables (from 10-21 depending on the index) and some examples are discussed here. The measure of human capacity (*Human Cap*) includes a variety of measures of general educational among the population, higher education achievements, and information technology use within the state.   The index on Research and Development Inputs (*ReschInv*) includes variables such as investments in academic R&D, ability of local academic facilities to secure external funding, and current state R&D expenditures. Measures of the availability of private capital (*RiskCap*) included the number of companies receiving venture capital investments, impact of IPOs on state economies, and number of business start-ups in a state. Characteristics of the local work force (*WorkForce*) measured trained scientists and engineers in the workforce and the integration of computer technology and IT across the state. The existence of high tech industries in the state (*TechConc*) was measured with a composite index that included growth of high tech industries, number of new industries above national average, and percent employment in the high tech sector, among others.

The analysis also includes levels of spending on higher education at the beginning of the study period (1998) as a mean of controlling for university research programs. While the creation of specialized S&T university-based research centers were included as measures of programmatic activity, there was no way to discern activities that may already be occurring or initiatives within state university-systems.   Higher education spending was used as a rough proxy measure of university capacity. Finally, change in levels of higher education spending over the study period (*10yr Chg*) was also included as a measure of expanding capacity and larger state-wide efforts to compete with other regional S&T clusters. Georgia's expansion of its university system over the past decade is an example.

Analysis

In order to understand the factors influencing state-level S&T portfolios a series of exploratory regression models were performed. The dependent variable used was one of the five different measures of state S&T activity discussed above. Differences across the specifications highlight the variation in state selection of S&T activities.

The first set of models examines two measures of state-level activities. The initial model utilizes a count of all state-initiated S&T programs during the study period. A simple Poisson regression was run against each of the five capacity indices reported for 2007 and the two measures of higher education spending. This is contrasted to a similar model run on the diversity of the research portfolio in each state. Table 2 below presents the full results.

The measure of state-level S&T as a count of programmatic activities is closely associated with the various measures of capacity. R&D Inputs, RiskCap, TechCon and WorkForce are all statistically significant at the 0.01 level or better. One measure of state higher education spending, HighEd'98, was significant at the 0.001 level, but has a tiny coefficient. The clustering of significant capacity measures suggests larger overall portfolio sizes for those states with better S&T infrastructure. The number of state programs is however not associated with the diversity of the portfolio (PortDiv).[3] Also the variable of HumCap has no association to

[3] The count variable and weighted diversity variable are actually uncorrelated to a surprisingly high degree (Corr. Coeff. = 0.01).

Table 2: Alternative model specifications of state S&T portfolios

Variable	Poisson Model on 'Count'	Regression on 'PortDiv'
Count	---	0.00 (0.01)
PortDiv	0.06 (0.11)	---
HumCap	0.01 (0.01)	0.01 (0.01)
R&D Inputs	-0.02 (0.01) **	-0.00 (0.01)
RiskCap	0.03 (0.01) ***	-0.00 (0.01)
TechCon	-0.02 (0.01) **	0.00 (0.01)
Work Force	0.02 (0.01) **	-0.00 (0.01)
HighEd'98	0.00 (0.00) ***	0.00 (0.00)
10yr Chg	0.31 (0.25)	0.32 (0.34)
Constant	0.52	0.11
Log likelihood	-179.07	
	Obs. = 50 Chi2 = 134.7 Prob > chi2 = 0.000 Pseudo R2 = 0.27	R2 = 0.07

the size of state S&T portfolios. This has some potentially interesting implications that are discussed further below.

The alternative specification, where state portfolios are measured only in terms of their diversity, has no statistically significant variables among those examined in this study. The negative result is presented here to illustrate the different processes that determine the size verses the scope of S&T activities. Additionally, it highlights the starkly different results dependent on the selection of measurement of state S&T portfolios.

The second set of models is intended to discern difference among the states in pursuing highly speculative research activities from those with more immediate applications. Three logistic regression models were utilized to compare specific programmatic activities within each state's portfolio. Results are presented in Table 3. Highly speculative activities were measured by the presence of funded nanotechnology programs within a state's portfolio. Sixteen states funded some type of nanotechnology research during the study period. These included most of the high capacity states (CA, MA, FL, TX & NY) as well as a number of low capacity states (UT, OR, SD). Of the variables examined here, only the total count of state supported programs was significant. The result was unexpected since as an emerging technology nanotech was expected to be closely associated with high levels of state capacity. Instead it appears nanotechnology programs are simply associated with large S&T portfolios.

The second model specification uses a selection of applied S&T activities to measure state activity directed toward local concerns. Thirty-five states had active applied research programs. The only two significant variables were the count variable and the measure of portfolio diversity. Since both portfolio diversity and applied programs are indices generated from the original dataset there is a modest degree of correlation (0.28) and the results are likely an artifact of correlation, however given the low correlation with the other state research portfolio measure it is kept in the model as a control variable. Dropping the diversity variable has no discernable effects on the results. As with nanotechnology programs, applied research is similarly associated with larger S&T portfolios without any discernable impact of state capacity.

The third specification focuses exclusively on states which created applied health research programs during the study period. Examples include New York's Center for Integrated Analysis of Neuronal Plasticity and Delaware's Advanced Technology Center for Medical

Devices. Two of the variables examined were found to be significant, the measure of portfolio diversity (PortDiv) and levels of risk capital available in the state (RiskCap). Health related investments are strongly associated with those states with more diverse S&T portfolios. Surprisingly, only levels of available risk capital were found to be significant of the various measures of state capacity. Interpretations of these results are offered below.

Table 3: Variations across different state investments in S&T

Variable	**Logistic regression on nanotechnology programs**	**Logistic regression on applied R&D programs**	**Logistic regression on health-related R&D**
Count	0.23 (0.11) *	0.51 (0.22) *	0.03 (0.08)
PortDiv	0.36 (0.88)	2.97 (1.53) *	5.42 (1.87) **
HumCap	0.05 (0.06)	-0.01 (0.07)	-0.07 (0.06)
R&D Inputs	-0.08 (0.05	-0.09 (0.07)	-0.12 (0.06)
RiskCap	0.03 (0.05)	0.10 (0.07)	0.18 (0.07) *
TechCon	0.06 (0.05)	-0.00 (0.06)	-0.01 (0.05)
Work Force	0.03 (0.03)	0.02 (0.06)	0.09 (0.05)
HighEd'98	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
10yr Chg	1.07 (2.35)	1.45 (2.52)	-0.12 (0.91)
Constant	-9.05	-6.27	-6.12
Log likelihood	-18.73	-13.52	-18.31
	Obs. = 50	Obs. = 50	Obs. = 50
	Chi2 = 25.22	Chi2 = 34.03	Chi2 = 31.41
	Prob > chi2 = 0.0027	Prob > chi2 = 0.0001	Prob > chi2 = 0.0003
	Pseudo R2 = 0.40	Pseudo R2 = 0.56	Pseudo R2 = 0.46

Discussion and Conclusions

While these results are presented as a preliminary analysis of a new dataset, they offer some initial insights into role of the states in S&T policy. There has been a disproportionate attention in the literature to the high spending and high performance states. While this is natural as professionals are attempting to follow the winners, if does mean many of the activities of the smaller states tend to go unnoticed. If the activities of a state are measured by the overall size of the S&T portfolio (or the level of spending as in much of the literature), many of the more interesting experiments in S&T policy will go unnoticed. As the results of model 1 illustrate, there is an enormous activity in S&T policy at the state-level and the depth and the scope of programmatic activities offer very different indicators of state activity.

The most important results of the models presented in Table 2, is the lack of significance of the human capital (HumCap) variable. One of the initial hypotheses was that S&T program by the states may be consistency driven. While HumCap is a broad index intended to measure basic education levels and technical proficiencies, it was expected that this would track very closely to demands for higher levels of investment in S&T. The fact that the other capacity indices, that tend to be measure industry activity and concentration, are significant suggests that if political consistencies are an important determinant of levels of state activity, it has to do with the mobilization of focused interest groups, not broad-based support of scientific research.

The set of models presented in Table 3 also provide some important directions for future research. Highly speculative programs (in this case nanotechnology) and applied (health) are pursued by different types of states. Highly speculative S&T activities tend to be associated with states with the largest overall portfolios (NY, CA, FL) while applied research are associated with states with broadly diversified S&T portfolios (UT, MI, IA). Equally important is that health research programs in particular are associated with high levels of available risk capital suggesting a high degree of specialization by states as they strategically allocation public investment. It also suggests that S&T policies may be directed as much to investigating solutions to local problems as toward broad-based economic development goals.

As the US faces increasing competition in science and technology from abroad, one of the competitive advantages it maintains is that of a robust federalist system. The evolution of the role of the states in S&T policy has changed in the past decade and understanding the strategies states have utilized in positioning themselves on this new landscape is an important research area. By examining S&T policy as a polycentric system in which states play a central role in pursuing research agendas this project offers a unique perspective on policy formation. Polycentricity offers a theoretical advantage over more top-down approaches in that it can better capture the full range of motivations underlying investment in innovation, the dynamic of competition and coordination among the states, and the interactions across public and private actors. Areas of activity in innovation policy extend both below the state, as the project has identified three county-level technology incubator programs, as well as numerous regional initiatives. The model of federal dominance in S&T innovation requires a careful reformulation to better account for the role of local and regional governments. This should include idea of the co-production of the public goods necessary for knowledge-based economies, and examination of the synergetic relationship between the public and private sectors, and how states strategically utilize the various resources at their disposal.

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